PLASTICS TECHNOLOGY

THE MAGAZINE OF APPLIED ENGINEERING

JULY 1955

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an article by F. W. Sheffler and J. C. Roller/page—352

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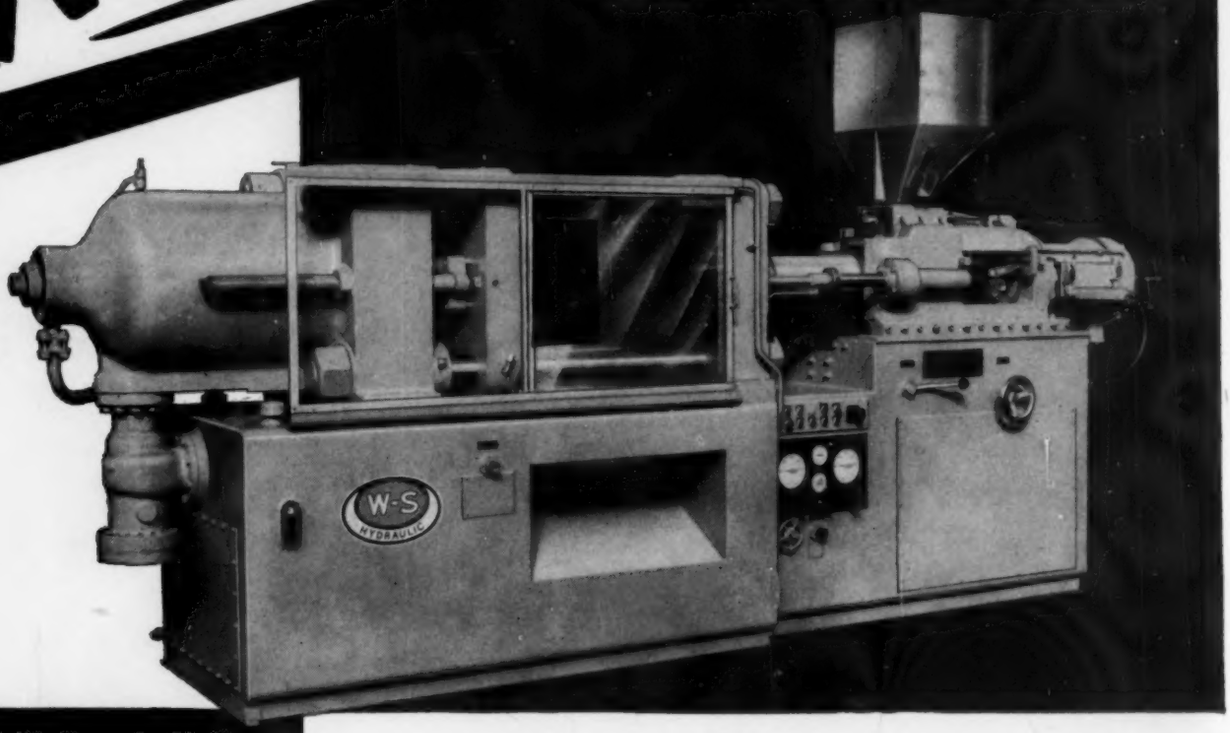

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JULY 1955

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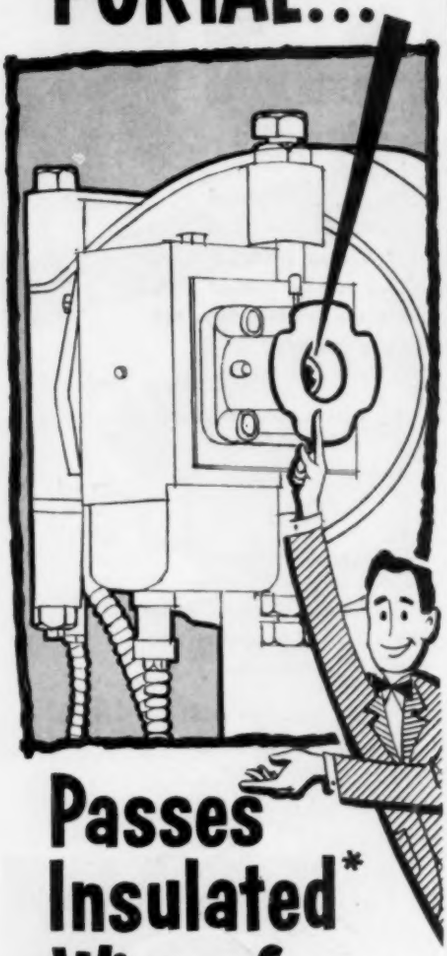

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Letters to the Editor

Dear Sir:

I was very much impressed by Dr. Bjorksten's introductory article and cannot say how much I endorse most of his statements. I was especially intrigued with his notes on page 15 under "Improvement in Chemical Techniques," more especially the necessity of avoiding the use of polymerization catalysts. In my April issue I have written a short editorial on this subject and cannot stress too much how I deplore the use of organic peroxides and cobalt naphthenate as catalysts for cross-linking polyesters. Manufacturers seem to have learnt nothing at all of the drawbacks encountered by the paint industry.

M. D. Curwen, Editor
Plastics,
London, England

• • •

Dear Sir:

We are in need of a catalog listing the companies in the plastics industry in the same way that companies in the rubber industry are listed in the "Rubber Red Book." Do you know of such a catalog or listing?

We have the latest copy of the "Modern Plastics Encyclopedia" but we find that this does not have the type of information which we need. Anything you can suggest along these lines will be very helpful.

H. F. Schwarz
The Sherwin-Williams Co.
Chicago, Illinois

(Unfortunately, there is no other listing or directory available that is comprehensive, probably because the plastics industry is growing so quickly that every list becomes obsolete before it is even finished. From our own files, we will attempt to answer specific inquiries whereever possible.—Editor)

• • •

Dear Sir:

A friend has told me of your magazine and, especially, of your April issue which contained a very fine article on vacuum forming. My business is engineering for, and the sale of, equipment and materials for the vacuum forming and sheet processing industries. Therefore, my interests are centered on such interesting magazines as yours. Would it be possible to obtain the April issue or a reprint of the article on vacuum forming it contained?

Ned L. Roberts
Manufacturers' Representative
Sherman Oaks, California

(A complimentary copy of our April issue has been sent Mr. Roberts, although it did not contain a formal technical article on vacuum forming.—Editor)

• • •

Dear Sir:

We have addressed requests for material information to various companies listed in the New Literature section of your publication. Inasmuch as only the company name and city in which it is located are given, several of these letters have been returned to us. Should we address these inquiries to your office in the future to be forwarded to the various firms by you, or what is the proper procedure to be followed?

B. J. Cagan, Technical Director
Eldon Development & Engineering Laboratories
Los Angeles, California

(We will forward any such inquiries, but this problem should be solved by the use of the Readers' Service Cards now being bound into each issue.
—Editor)

• • •

Dear Sir:

I have read the first two issues of PLASTICS TECHNOLOGY with great interest, and in particular your March Editorial on "The Engineering Challenge to Plastics."

Publicity for engineering uses of plastics is a subject that has been very close to our hearts since we entered the Plastics Field several years ago, and we heartily agree with your remarks.

With our best wishes for the success of your Journal.

A. J. Pickett, Editor
The Rubber & Plastics Age
Tenterden, Kent, England

• • •

Dear Sir:

One of our important overseas connections, who does laminating of cotton textiles for the manufacture of rubber-soled shoes by using fabrics on the face consisting of about 8-10 ounce weight cloths with backing material of various weights, running from 4-8 ounces per square yard, has asked us to supply them with samples of Poly-vinyl (probably polyvinyl chloride or polyvinyl acetate) together with a description of the procedure used in applying such combining or laminating substances.

We understand that these combining substances are spread on the back of the face cloth, and then back and face cloths are run between heavy, heated rollers which cure the combining product and cause complete adherence of the fabric.

Can you put us in touch with a chemical house which can furnish this poly-vinyl product, or give us the name of such a manufacturer, especially one who can inform us as to the procedure necessary for doing the combining, particularly the degree of heat that must be used for complete curing?

A. Whiteside, Manager
Converting Department
Turner Halsey Co., Inc.
New York, New York

(A list of vinyl coating companies has been sent to Mr. Whiteside. The process of vinyl laminating will be described in detail in a forthcoming article.—Editor)

• • •

Dear Sir:

We have a problem that is quite prevalent in the molding industry. We have a battery of 10-year old horizontal injection machines, each eight ounces in capacity. What can be done to increase the plasticizing capacity, clamping, injection pressure, and press speed of these units in order to make them more competitive with newer machines?

(Identity withheld)

• • •

We invite letters from our readers for publication in these columns. Such letters may be of comment or criticism, requests for information, or of general interest. The only requirement is that all letters must be fully identified as to name of sender, company affiliation, and address.

Letters requesting information on technical or engineering problems will be printed to elicit replies by the readers, either directly or through these columns. Upon request, the identities of such "problem" letters will not be divulged.

—The Editor

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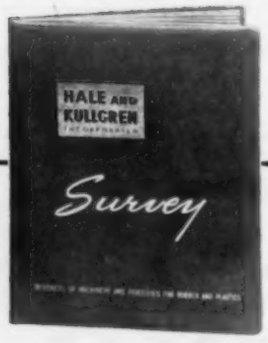

Program for Profits

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NEWS in BRIEF

A low pressure polyethylene made by the Ziegler process has been announced by DuPont. Pilot-plant quantities are expected by early fall from the company's Sabine River Works near Orange, Tex. The new Alathon consists of a group of widely differing materials rather than a single resin. This modified polyethylene is expected to greatly widen the range of properties of resins now produced commercially. Previous modifications have produced tough, pliable films for packaging; high density materials for piping; and electrical polyethylenes with improved heat resistance.

Polyethylene production will triple present output, according to Bakelite's Intemann who expects annual production to reach 627 million pounds. Potentials for paper-polyethylene combinations are virtually untapped, and the outlook for disposable hospital sheeting is very bright.

Future of petrochemicals is optimistic, too. Current annual production totals about 30 billion pounds, as compared with 150,000 pounds made in 1920, and indications point to continuing growth. Spurring this increase is the rise of petroleum-derived plastics and rubbers.

Insufficient plastics engineering data often leads to overdesign of products in an effort to avoid the pitfalls caused by underdesign, says Schoene of Naugatuck Chemical (see guest editorial, page 362). Such overdesign almost always results in a product which costs more, pound for pound, than the material it replaces. The plastics industry must accumulate proper engineering data if it is to expand beyond specialty and decorative products. When properties are known, uses and improvements follow inevitably.

Plastics industry expansion announcements continue to come thick and fast. Falls Engineering & Machine will double its production, engineering, and office facilities in Cuyahoga Falls, O. Goodrich Chemical will erect a three-story office building in Cleveland. A $3,000,000 engineering and research building, for new product development, is being constructed by Goodyear Aircraft in Akron, O. A new building, ten times the original plant size, will house the expanded facilities of Resdel Engineering, in Pasadena, Calif., manufacturers of dielectric heaters for the plastics industry. Thiokol has doubled production capacity for its two low temperature plasticizers to meet increased demand from the vinyl and rubber industries.

Company changes this month saw the purchase by Carlisle Chemical of Advance Solvents & Chemical and its subsidiaries, and the merger of Art Roll Leaf Stamping and Art Marking Specialists into a new company, Art Decorating. Contrary to previous reports, Hydraulic Press Mfg. will continue as an independent company and has announced a series of key personnel appointments.

New Materials of interest this month (see page 374): a combination light-stabilizer and destaticizer; a powder form of half-second butyrate; an impact-resistant epoxy tooling compound; Sisalana fibers as decorative reinforcements for plastics; a stabilizing plasticizer for vinyls; and an acrylic protective coating.

New Equipment worthy of mention (see page 376) includes: a temperature control system for batch polymerization kettles; a multi-purpose hand tool for cutting plastics; a series of diffusion and booster pumps for use in vacuum metallizing; paper-type temperature indicators and recorders; and a new line of sheet plastics dicing machines.

New Products to be noted (see page 378): PVC-lined steel pipe; vegetable parchment release backings; unicellular expanded polystyrene; polyester protective coatings; reinforced plastic tanks for electroplaters; vinyl picnic bags; all-plastic tracks for combination storm-screen windows; rigid vinyl-and-metal laminated printing plates; ventilating skylights; styrene-and-nylon lipstick containers; corrugated vinyl sheets for luminous ceilings; and vinyl panels formed to give a three-dimensional effect.

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PLASTICS TECHNOLOGY

JULY, 1955

EDITORIAL: The Need for Educating the Plastics Industry

Education of consumers is currently a popular subject in the plastics industry. The need for such education is evident, and teaching the consumer to know what to expect of plastics and how to use them properly should do much to reduce the numerous misapplications plaguing the plastics market. In this program, informative labeling of plastic products and fulfillment of the SPI program to educate consumers to demand products bearing the vinyl seal of quality are necessary steps. However, this program should be accompanied by a campaign of education aimed at the plastic industry itself.

•

There are still many people in the plastics industry who lack a true understanding of the importance of making products that are engineered to fit the requirements of their applications. Unfortunately, these persons give only lip service to the idea of making engineered products, and are concerned primarily with making the lowest quality items that can be sold profitably. The excuse, too often, is "If I don't cheapen the product, my competitor will do so and undersell me."

There is no gainsaying the importance of price and cost factors in making a product, since the best item in the world is not satisfactory if it cannot be sold. The danger is that too much emphasis may be placed on economic considerations at the expense of engineering.

In endeavoring to balance economic and engineering factors, an exact balancing point usually cannot be obtained. Instead, there is an area wherein costs can be lowered and properties reduced progressively without making them unsuitable. The point at which these properties become entirely inadequate is more clearly defined, but the engineer is at a disadvantage in arguments with a non-technically trained management that is interested in keeping costs down and profits up, and prefers not to be convinced of the need for factors that will raise costs.

•

There is no quick and easy solution to this problem. We need a program designed to educate the people in the plastics industry as to the proper importance of engineering and its relation to economic factors. Such a program would be long-range in nature, but must be effected if the plastics industry is to achieve maturity.

A truly mature industry has the responsibility of (1) supplying the best products for specific applications, (2) educating its customers to expect and demand the best, and (3) resisting the impulse to make quick profits because of customer ignorance. These three factors are of equal importance and are closely interrelated. Educating our customers is not enough if we ourselves have much to learn.

Arthur M. Merrill

Editor

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Stress Cracking (Crazing) of Polystyrene—Part I

The first of a two-part article describing a new test for critical stress showing why some applications of polystyrene are unsatisfactory, and indicating remedies based on proper design and molding.

E. E. ZIEGLER *and* W. E. BROWN

Plastics Technical Service, Dow Chemical Co., Midland, Mich.

In recent years, many people have purchased plastic articles assuming, on the basis of visual perfection, that they were well made. From previous satisfaction with other materials, they trusted that with reasonable care the plastic products would perform their intended functions for an extended period of time. Some of these people have been well pleased but, unfortunately, others have not.

Among the latter were some users of plastic kitchen utensils who, although they avoided heat, nevertheless watched small internal cracks develop over a period of time, expand throughout the part, and sometimes cause complete failure. Still others witnessed gradual degradation of such miscellaneous plastic parts as battery cases, coat hangers, brush backs, bottle closures, and food containers.

These plastic parts failed because of stress cracking or crazing. It was to resolve some of the unknowns in this problem of the stress cracking of polystyrene, in particular, that this work was undertaken. It was hoped that a relatively simple, fast, and reproducible test method might be worked out for investigating polystyrene's crazing tendencies. In addition, it was thought that this test method could be used for determining the stress-strain relationships and associated craze resistances of several plastic materials in air, water, and a wide variety of reagents. Finally, it was hoped that information gained from this investigation would permit the intelligent choice of plastic materials for specific end-uses, the design of plastic parts which would function more satisfactorily over long periods of time under adverse conditions, and the specification of any post-forming treatments as might be necessary to insure long service life.

It should be pointed out that this work was never intended to cover all the theoretical concepts of crazing, its mechanism, or its relationship to polymer chemistry. It was intended to be a practical approach to an existing problem, and it was hoped that the tests developed

Earl Ziegler received a B.S. in Mechanical Engineering from Wayne University in 1936. He was with General Motors Truck Co. from 1936-1940; Standard Oil Co. of Ind. from 1940-1943; and has served with Dow since 1943. Mr. Ziegler is active in Plastic Wall Tile Standards at the Bureau of Standards and the SPI. He holds membership in ASTM, SPI, ISO, and the Midland Engineering Society.

William Brown was graduated from the State University of New York in 1951, with a B.S. in Pulp & Paper Manufacture. Since joining Dow in 1951, he has been concerned with plastics testing and has served with several industry standards and specifications committees. Mr. Brown is a member of the ACS, ASTM, SPI, and the Midland Engineering Society.

and the conclusions drawn would be of practical value.

Nature of Stress Cracking

Stress cracking may be defined as the development of fine cracks on or under the surface of a plastic part. These cracks may range from those of relatively large size, individually visible to the unaided eye, down to those of almost microscopic size visible en masse as "water bloom." Stress cracking is difficult to see when it is known to exist in opaque polystyrene moldings, and can most easily be seen (by reflected light) in clear or light colored translucent moldings. Stress cracking very ofen starts with the development of a few small isolated cracks, and may progress into larger patterns containing hundreds of small cracks. If a sufficient number of these patterns join to create one or more large cracks, mechanical failure may result.

Stress cracking is thought to result from localized stresses of greater magnitude than the material can accept. As the name implies, stress cracking is associated with stresses contained in or exerted on the plastic molding. Included in this category are the following five types of stresses:

(1) Orientation stresses caused by forced molecular alignment or disturbance during the molding operation.
(2) Packing stresses caused by forced injection of additional polymer during the period of thermal contraction of the plastic material cooling in the mold.
(3) Thermally-induced stresses caused by differential cooling of the plastic during the molding process.
(4) Stresses caused by thermal shock on the entire molding, or by localized overheating of certain areas during machining and finishing operations.
(5) Mechanical stresses resulting from externally applied loads.

"Solvent crazing" is associated with the lowering of stress cracking resistance by chemical action of a wide variety of reagents. One of many references to this in the literature (1)* explains this phenomenon as a plasticizer action which reduces the attractive forces between polymer chains so that they may pull apart at the lower strain. Of course, it is very common for stress cracking to result from a combination of chemical action and mechanical stress.

Test Method

Anyone who has had experience in the tensile testing of thermoplastic specimens, particularly polystyrene, is familiar with the development of stress cracking or crazing which takes place before the specimen is actually broken. That such crazing can easily be observed on standard tensile bars, and that elongation of such specimens can be recorded accurately, would lead to the belief that large sized, conventional testing equipment might be ideal for the investigation of crazing. Several practical difficulties prevent this from being so, among which are the difficulty of obtaining and holding an exact elongation on a given area of test specimen, the difficulty of immersing a loaded specimen in various reagents, and the high cost of tying up expensive equipment for long periods of time for the determination of very few experimental values.

Some thought was given to the use of a simple cantilever beam of uniform cross-section rigidly supported at one end and either loaded or mechanically displaced at the other end. Theoretically, this simple test set-up would provide a smooth tensile curve and uniform variation in elongation. In actual use, it was thought that difficulties would be encountered in immersing the assembly in liquid reagents, and in preventing cold flow which would result in changing the elongation.

It was thought that these difficulties could be eliminated and a simple useful test result from clamping a test strip of plastic over a "bending form" so designed as to provide a gradually changing radius of curvature and corresponding stress as well as strain in the test specimen.

By close visual examination of the stressed specimen in bright light it would be possible to observe heavy crazing in the highly strained portions of the bar, and to follow this out into the less strained portions until the location of the last significant craze mark could be established. Percent elongations could be calculated accurately and varied over a wide range. Cold flow would be essentially eliminated from consideration no matter how long the test, and the entire unit could be easily handled, transported, or immersed in reagents, depending upon the needs of the test program.

Accordingly, such bending forms were made from ½-inch square stainless steel to conform to three different curves having elongation ranges (on 0.125-inch thick plastic specimens) as given in Table 1:

Table 1. Elongation Ranges of Bending Forms

Form	Equation	Shape	Range of % Elongation
#1	$y^2=6x$	Parabolic	0.26-2.3
#2	$y=0.5(400-x^2)$	Elliptical	0.19-1.4
#3	$y=0.1\ (400-x^2)$	Elliptical	0.08-0.76

These forms, together with small adjustable clamps for holding the plastic specimens in place on the forms, are shown in Figure 1.

A great deal of work was done in the laboratory to establish the suitability of this test method, as well as the accuracy of each bending form. The data presented in Table 2 are typical of the values obtained, and indicate excellent correlation between the short-time critical elongations obtained on injection molded specimens tested on a Baldwin-Southwark Universal Tester and the newly-made bending forms.

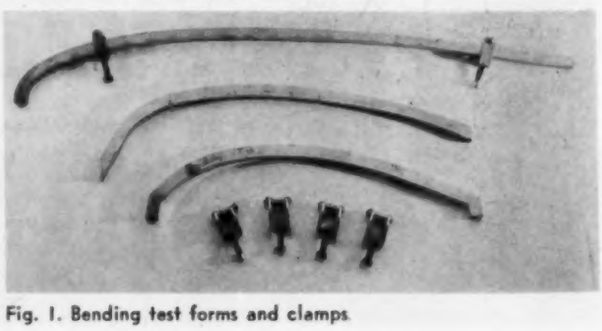

Fig. 1. Bending test forms and clamps

* Numbers in parentheses refer to bibliography at end of article.

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Table 2. Correlation of Bending Form and Tensile Test Results on Injection Molded Bars

Polystyrene Formulation	Critical Eongation, %	
	Bending Form	Tensile Test
Styron 666 (general-purpose	1.36	1.38
Styron 700 (heat-resistant)	1.39	1.30
Q-767 (chemical-resistant)	>2.3	2.35

Test Specimens

One of the problems invariably associated with such an investigation is that of obtaining a large supply of uniform test pieces. That such an order cannot be filled easily by conventional injection molding practice is known from extensive experience, and is mentioned in the literature (2).

It is known that frozen orientation stresses, thermal cooling stresses, and resulting mechanical strengths can vary considerably between successive shots, even though injection molding conditions remain "unchanged." It is known also that annealing can be very effective in relieving stresses caused by thermal gradients during molding, machining, or finishing operations, but that it is of little or no benefit in relieving orientation stresses involving molecular configuration (3). Annealing of injection molded specimens, therefore, was thought (and subsequently proved) to be inadequate for such a test program wherein stress cracking is so critically affected by internal stresses as well as molecular configuration.

The fact is well known that there is considerable variation in mechanical strength with direction and amount of orientation. Whereas the tensile strength of completely relaxed moldings of polystyrene is around 5,000 psi., this strength can be increased by nearly 150% in the direction of considerable orientation (up to 230% by hot drawing), and can be reduced to 30% of its original value at right angles to orientation direction (4). At hot stretching values variously reported from 230-1,100%, crazing no longer occurs (4, 5).

With this in mind, it was apparent that unoriented compression molded test specimens should be considered for further test work. Table 3 summarizes data which indicates clearly the excellent correlation between the critical elongation of compression moldings and injection moldings stressed across the direction of flow. This correlation was thought highly significant because injection moldings in actual use stress crack at right angles to the applied stress and along the lines of least strength, i.e., stress cracking occurs parallel to flow lines.

Table 3. Effect of Plastic Flow on Critical Elongation of Styron 666 Clear at 75° F.

Reagent	Critical Elongation, % (After 30 secs.)		
	Injection Molded		Compression Molded
	With Flow	Across Flow	
Air	1.66	0.80	0.78
Sulfuric acid (sp.gr. 1.3)	0.96	0.44	0.43
Ethyl alcohol	0.92	0.29	0.24
Propyl alcohol	0.95	0.56	0.50
Lactic acid	1.0	0.69	0.68
French dressing	0.41	0.31	0.30
Mustard	0.91	0.34	0.34

To summarize, injection molded specimens are difficult to make in quantity with sufficient uniform internal stress conditions to allow for accurate determination of critical elongation under a variety of conditions. Annealing of such specimens does not provide the desired answer. The critical elongation of conventional injection molded specimens varies as much as 100% from "with flow" to "across flow" direction. Polystyrene moldings in actual use craze along their flow lines. To duplicate this in laboratory tests requires stressing injection molded test pieces in the "across flow" direction.

On the other hand, compression molded specimens are advantageous for this test work because they are quickly and easily made in quantity with uniformly low internal stress; they require no careful machining or annealing; no account need be taken of the direction of plastic flow; critical elongations correlate well with those obtained on injection moldings tested "across flow" (this data should be useful in predicting craze-free life of molded articles); and the critical elongations thus determined are known to be practically the lowest ob-

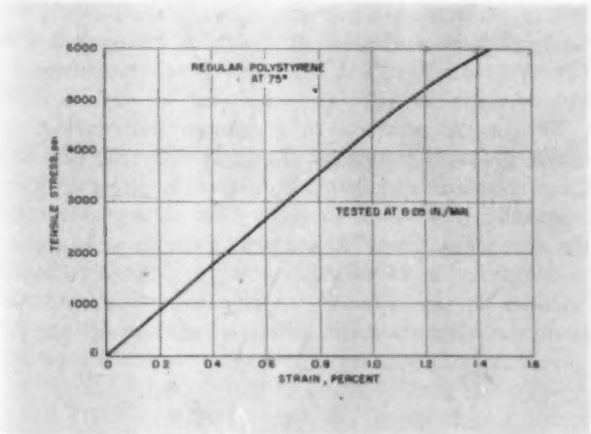

Fig. 2. Typical stress-strain curve for polystyrene

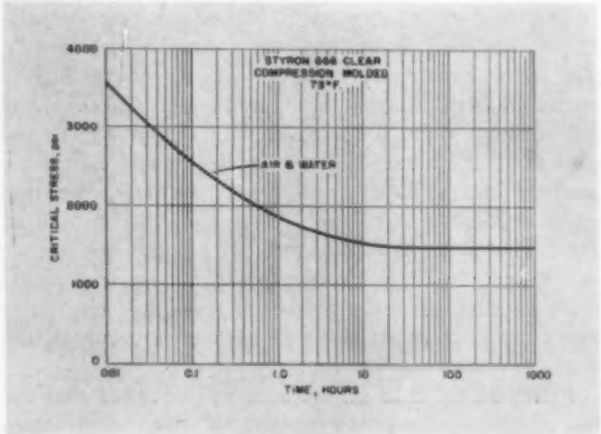

Fig. 3. Time dependence of crazing as shown by critical stress

tainable. These low elongations can be translated directly into readily interpreted tensile stresses (internally contained, externally applied, or both) below which even the weakest portion of the molding will perform satisfactorily, but above which it may stress crack.

The stress cracking of polystyrene was studied by bending ⅛-inch thick compression molded test bars on the bending forms previously described. Critical elongations were determined by observing the lowest elongation at which significant crazing took place. This was accomplished by very careful visual observation of the test specimens on the bending forms under bright light.

Test Results

Throughout the remainder of this work frequent mention will be made of specific stresses and elongations of polystyrene. The significance of these values in pounds per square inch or percent, respectively, may be visualized readily by referring to the typical stress-strain curve of polystyrene shown in Figure 2. This relation may be useful whenever it is desired to translate stress values into elongation or vice versa.

Time Dependence

Before undertaking the study of many variables and unknown factors in this problem, it was thought necessary to determine the time dependence of stress cracking on polystyrene held at constant strain and constant temperature. Accordingly, this work was done over a six-week period in air and water at 75° F., with results as shown in Figure 3.

Unoriented compression molded polystyrene has an instantaneous (30-second) critical elongation of 0.78%. Held under conditions of constant strain, polystyrene's critical elongation is lowered by approximately 50% in five hours, and does not reach an equilibrium value of 0.32% for approximately two days. Thereafter, no significant change takes place for one month, and it is thought safe to predict that no further drop in critical elongation takes place.

It is generally agreed (1, 6) that stress cracking is the beginning of failure in plastic moldings. This is an unavoidable conclusion when it is realized that stress cracking is composed of small but definite cracks or openings within the plastic material. When a crack appears, it naturally reduces the area over which the remaining load must be distributed.

The rate of penetration of stress cracking in polystyrene has been determined over a range of stresses (7). The results can be summarized by saying that for a given stress, crack penetration increases linearly with time, and for constant time, it increases with stress (8). In the case of constant load application, this means that as the number and size of stress cracks increase, the unit stress becomes progressively greater on the unruptured area. Therefore, it is obviously of utmost importance in constant load applications to prevent stress cracking from starting, since the inevitable result of even minor stress cracking under these conditions is eventual mechanical fracture of the molding.

Referring again to Figure 3, it will be noted that the loss of critical elongation from "zero" time to minimum equilibrium attained after 50 hours amounts to approximately 60%. This correlates well with previous work done on long-time tensile loading of injection molded polystyrene which showed that test bars would hold only about 40% of their rated ultimate tensile strength in long-time constant load tests.

This is an important point for the designer, and emphasizes the need for a large safety factor in the design of polystyrene moldings involved in tensile loading. It also indicates the need for more complete and, actually, more realistic values of tensile strength in plastics property determinations.

Actually, a polystyrene molding cannot withstand the quoted ultimate tensile stress of 6,500 psi. for more than a few seconds without breaking. From the critical elongation values just quoted, it can be seen that unoriented polystyrene can withstand no more than 0.32% elongation or approximately 1,500 psi. for an indefinite period without breaking. Polystyrene will not hold even this load if the exposure temperature is raised above 75° F., or if reagents other than air or water are brought into contact with it.

The conclusions just drawn for constant load do not necessarily apply to applications involving constant strain. In this case, deflection or elongation is held constant but the load is not. The occurrence of a few craze cracks under such conditions may well mean that the "weak links" in the molding have been broken, and that the remaining stronger portion can accept the elongation involved. Consequently, by virtue of some creep or cold flow, the actual stress becomes progressively lower and the molding maintains its visual appearance and mechanical strength without further change as long as the loading conditions remain unaltered. This phenomenon has been observed many times during constant strain tests on bending bars.

Much the same conclusion has been drawn by Hsiao and Sauer (9) who report that "visible crazing cracks will not necessarily produce fracture but will reduce the total load the specimen can carry." They explain many of the facts pertaining to the inception, growth, and location of crazing cracks in polystyrene in terms of orientation and the separation of domains** of molecules under the action of tensile stress.

They point out that molecular domains which are at right angles to the applied stress open up first and initiate the phenomenon of crazing. Under proper load conditions, "it is possible for many crazing cracks to occur before fracture, because the micro-openings soon run up against other domains or groups of molecules not so favorably oriented for separation and then they are automatically halted."

The important effect of orientation on crazing and tensile strength is further emphasized by the fact that these domains can carry considerable stress in their longitudinal direction, but only very little stress in the transverse direction. Thus, when tensile stress is applied in the direction of orientation to specimens previously oriented to, say, 1,000%, crazing is not observed because there are no domains left oriented at right angles

(Continued on page 361)

** A "domain" is described as a group of molecules arranged together in more or less cylindrical form, with the various long-chain molecules essentially parallel to one another within the group.

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Plastics in the Atomic Energy Program*

How plastics can be utilized in atomic energy programs, and the effects of radiation on plastics.

About six years ago a program was started at Oak Ridge National Laboratory to make a systematic study of the changes that occur in plastics when subjected to nuclear radiation. The impetus for this work came from two sources: a scientific desire to find out what happens to polymers when subjected to high energy radiation and why, and a realization of the need to obtain quantitative data which the engineer could use when designing equipment for use in a radiation field. A large number of the properties that were selected for study therefore were of direct engineering value and tests were conducted according to ASTM standard procedures wherever practical.

Some of this engineering data will be presented to illustrate ways that plastics are affected by radiation. Most of the data will apply to polymers rather than specific plastic formulations, and there will be no sharp distinction made between plastics and elastomers. The mechanisms of the reaction of high energy radiation with polymers will only very briefly be pointed out to establish a basis for the discussion of the changes that occur in physical properties.

There are very few materials that are as easily affected by high energy radiation as organic materials, and the polymers will suffer large physical changes much faster than any other class of solids. This poses a problem, and at the same time opens a new and interesting avenue for research.

The problem is how can we live with these materials in an intense field of high energy radiation. The answer is that we must know what is going to happen to the material. Once you know what will happen, you will decide first if there is a problem or not. If there is a problem you usually have three choices: (1) you may decide how long the material is useful and have frequent replacements; (2) you may decide to shield the object to reduce the radiation intensity; or (3) you may move this piece of equipment to a place of lower radiation intensity. Sometimes, you must replace the piece with one made of a less vulnerable material.

Applications for Plastics in Atomic Energy

Some of the most troublesome problems have come from the use of plastics in nuclear reactors and, for this reason, it is perhaps the best place to illustrate the common every-day uses for plastics in a radiation field. One often hears the question: Is there really a need for plastics in the reactor business? Since these materials are so easily affected by high energy radiations, there is a temptation to say we just won't use these materials. This is not really the easy way out because it often creates very difficult design problems.

In the early days of reactors, we stacked up a large pile of graphite interspersed with uranium, placed some reflector around it (usually concrete or paraffin), and had a reactor. Today, we talk about power producing reactors, mobile reactors (machines for driving submarines and airplanes), and, perhaps, reactors for energy to produce chemical reaction. This new era in the reactor business has created a materials problem which may be more serious than any other problem in this business today. Plastics cannot solve this problem, but the problem will be somewhat relieved if we can use the organic

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polymers in the ways in which they are most useful under ordinary conditions.

Some possible applications for plastics in normal type usage are immediately obvious. In high power reactors, there is either a circulating coolant or circulating fuel or both, and this means pumps and all the auxiliary equipment that goes with the pumps. We would then find a good many of the following places for plastics or elastomers: gaskets of some type; diaphragms for valve operators or other pressure transmitting devices; hoses, tubes and flexible couplings; insulation for electrical leads, thermocouples, electronic instruments, and motors; valve seats; and the like.

In other instances, we might like to use plastic vessels or tanks for radioactive corrosive liquids. In a mobile reactor, we would be concerned over the rubber tires, perhaps, the material that seals the windows into the vehicle, or the paint. Many present-day chemical separations are most easily accomplished with ion-exchange resins. If the material is radioactive one must surely consider the effect of radiation on the resin bed.

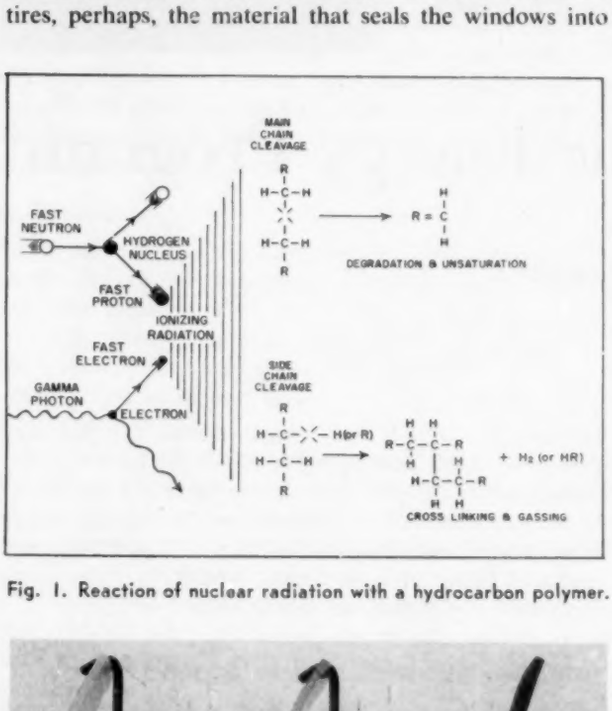

Fig. 1. Reaction of nuclear radiation with a hydrocarbon polymer.

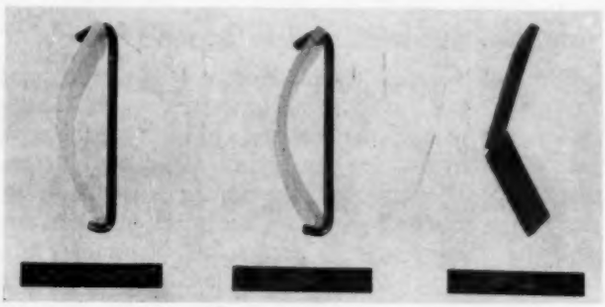

Fig. 2. Effect of radiation on polyethylene.

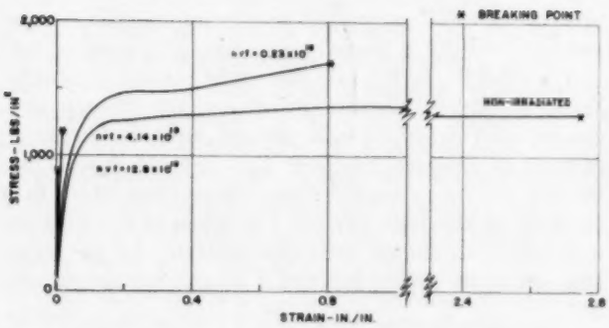

Fig. 3. Stress-strain curves for pile irradiated polyethylene.

There are several ways in which plastics can be useful in the atomic energy field as a result of the reaction of radiation with the polymer. None are highly exploited but all have found their place in atomic science. Because fast neutrons can be slowed down to thermal energies most effectively by hydrogen, hydrocarbons become excellent moderating materials. Unfortunately, the reaction which slows down the neutrons also damages the plastic so that it cannot be considered as a moderator for a very high flux reactor. Plastics are used, however, for reactor experiments.

The same reaction that makes the hydrocarbon so good as a moderator of fast neutrons also makes it useful as a shield material. Fast neutrons are very difficult to absorb, and so the standard practice is to slow them down to thermal energies where they are very readily absorbed by boron, cadmium, or a number of other materials. A fairly common material for this purpose for certain specialized applications is a plastic containing boron carbide.

This most publicized property of plastics to shield fast neutrons has led to numerous proposals for a "universal radiation shield" that uses thin sheets of plastic with heavy materials for gamma radiation. A good many of these schemes have come from people in the plastics industry; and that is why it is mentioned here. You can't stop fast neutrons with thin sheets of plastic. It takes a considerable thickness of plastic to accomplish this, sometimes as much as several feet.

Plastics are sometimes used to measure the intensity of radiation. They can be used to monitor virtually any type of radiation because they react with all types of radiation. Gamma, beta, x-rays, etc., are more easily monitored by some means like photographic films, activation measurements, or the like. Fast neutrons, however, are more difficult to monitor. For some applications, this is the most easily accomplished by measuring the energy dissipated in a plastic due to the collision of fast neutrons with the hydrogen. The change in some physical property can often also be measured.

Certain plastics are darkened by radiation and, therefore, are useful in making autoradiographs. A thin sheet of plastic has an advantage over photographic film where the radiation intensity is high, because it is less sensitive than the photographic film. This technique is particularly useful for showing the location of a highly radioactive specimen that is imbedded in a less radioactive material. Since the specimen would have to be handled remotely, there is a great advantage in increasing the exposure time which might be only a fraction of a second for x-ray film.

Nuclear Science in the Plastics Industry

There are three ways in which nuclear science may possibly be used to advantage in the plastics industry: (1) use of atomic radiation and radioactive materials as a research tool; (2) use of high energy radiations to induce polymerization; and (3) by use of high energy radiation to change the physical properties of plastics.

The first method is one that I hope you are all aware of, and it is, of course, not specific for the plastics industry. The use of radiation and tracer techniques as a research tool will not be discussed here, but you should try it, if you have not already, for engineering research.

The reaction of high-energy radiation with a polymer to cause cross-linking will, of course, also go on with the monomer. Cross-linking of the monomer can be similar to the polymerization process. The resultant polymer would probably have more of a three-directional structure, and in general, it would be expected that the radiation-induced reaction would be more random. Too little data is available now to predict what would happen to the various monomers. Some studies of this sort have been carried out at Brookhaven National Laboratory and it has been found that some materials that are most easily damaged by radiation are also most easily polymerized by radiation. By the use of radiation the polymerization reaction can sometimes be carried out at a lower temperature and pressure. Reactions that require catalysts often can be done without the catalyst if performed in a radiation field.

In order to get enough energy to carry out large-scale polymerization reactions by radiation, the use of a nuclear reactor might be considered as the radiation source. The present cost of such an installation would be prohibitive if the reactor were used for this purpose alone, but it might be feasible to make plastics as a by-product if this proved to be the most productive way of using up the excess energy. The best chance for using radiation for polymerization would be in the production of some new material with very desirable properties that was very difficult to make by other means. A reaction in which radiation was used only as a catalyst might be more promising, since a much smaller radiation source would be required, and, therefore, the source need not be a reactor.

The infrared spectrum of some irradiated elastomers shows the reactions to be very similar to those of vulcanization. It has been suggested that if vulcanization could be carried out without the additives that are normally used to cause this reaction, a superior product might result.

Effect of Radiation of Plastics

What about the effect of radiation on the mechanical properties of plastics? Can we produce amazing new materials by bombarding plastics with nuclear radiation? The changes that occur may seem amazing, but are not nearly so useful as some sources would have you believe. At least we do not know as yet if the changes will prove useful or not.

When polymers are subjected to high-energy radiation, they are all ultimately destroyed; that is, their useful properties are destroyed. The radiation dose to effect this change is not too great but, fortunately, it varies from the most easily damaged material to the most radiation-resistant material by a factor of more than 1,000. However, there is a transition period before the radiation begins to have a deleterious effect when many plastics show some improved properties.

The improvement in one property is usually accompanied by a loss in another property. For example, the

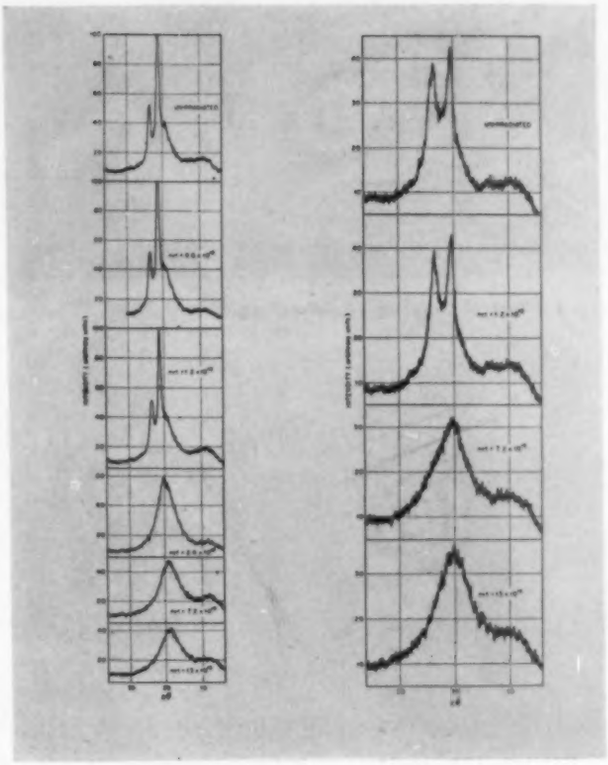

Fig. 4. X-ray diffraction patterns: (left) irradiated polyethylene; and (right) irradiated Nylon FM-1001.

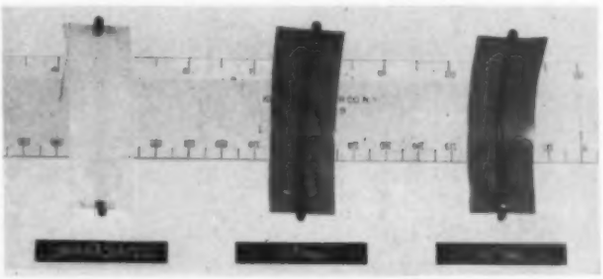

Fig. 5. Effect of radiation on nylon. Brass rod has been placed behind each specimen.

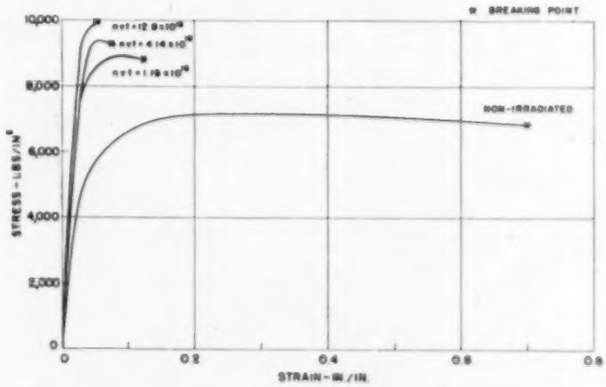

Fig. 6. Stress-strain curves for pile irradiated Nylon FM-3003.

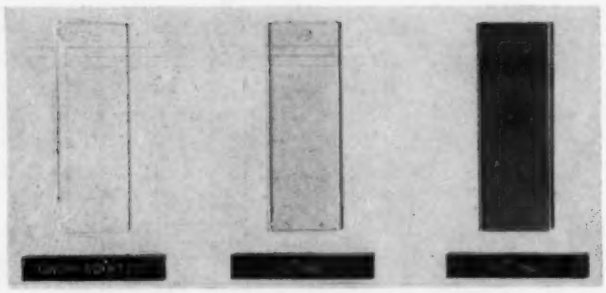

Fig. 7. Effect of radiation on polystyrene.

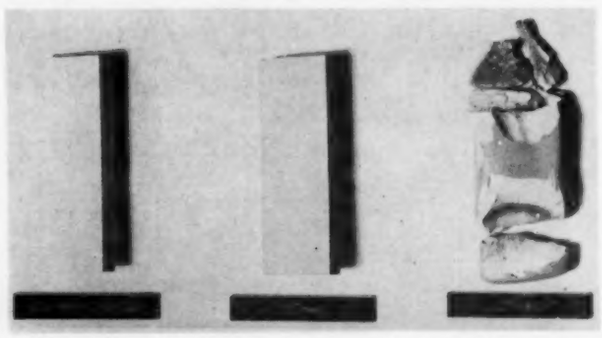

Fig. 8. Effect of radiation on an unfilled phenolic.

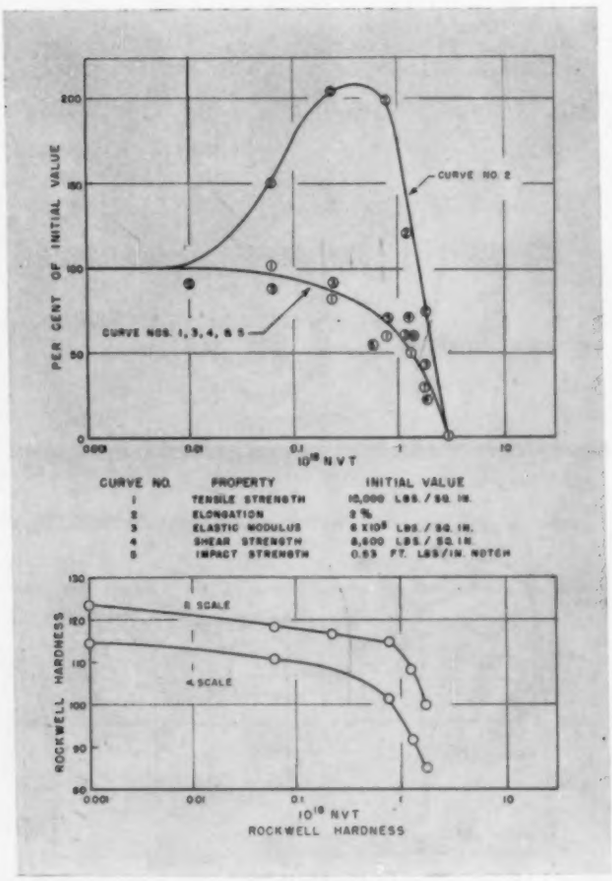
PER CENT OF INITIAL VALUE
CURVE NO. 2
CURVE NOS. 1, 3, 4, & 5
10^{18} NVT
CURVE NO. PROPERTY INITIAL VALUE
1 TENSILE STRENGTH 10,000 LBS. / SQ. IN.
2 ELONGATION 2 %
3 ELASTIC MODULUS 6 X10^5 LBS. / SQ. IN.
4 SHEAR STRENGTH 8,600 LBS. / SQ. IN.
5 IMPACT STRENGTH 0.53 FT. LBS/IN. NOTCH
ROCKWELL HARDNESS
R SCALE
M SCALE
10^{18} NVT
ROCKWELL HARDNESS

Fig. 9. Property retention of an unfilled phenolic upon radiation.

tensile strength will increase but elongation will decrease; impact strength may increase but the tensile strength will decrease; and elongation may increase at the expense of softening the material. Whether or not one can put these changes in properties to good use depends on whether the improved properties overshadow the deleterious effects.

Another question is whether the change can be brought about only by radiation or whether it may more readily be accomplished by other means, such as further polymerization when making the material or by using more plasticizer, filler, etc. Very little research has been done along these lines.

Reaction with Hydrocarbon Polymers

When high-energy radiations are passed through a material, they lose some energy to the material. Heavy particles (fast neutrons, protons, alpha particles, etc.) may collide with the nucleus of an atom or may cause excitation and ionization.

For metals and inorganic materials the collision-type reaction with a heavy particle is the important one.

For organic materials the excitation and ionization reaction cause such a large change that in most cases, particularly hydrocarbon materials, it is the only reaction that need be considered. The result can be looked upon as a broken bond which can occur either in the main polymer chain or in the side-chain. For main-chain cleavage, the result is degradation and unsaturation. For side-chain cleavage, the result is cross-linking plus the evolution of gas. How the physical properties of any particular material are affected depends upon which reaction takes place or is predominant.

A graphic illustration of this reaction is shown in Figure 1 for the two most important radiation sources in a reactor as far as the effect on a sheet of plastic is concerned. The fast neutron will most often collide with a hydrogen nucleus to eject a fast moving charged particle, the proton. The gamma proton will most likely be scattered by an electron, and the electron becomes a fast-moving charged particle. Both of these secondary particles lose most of their energy by excitation and ionization of the polymer. This is a very oversimplified picture of the reaction of radiation with a polymer, but it serves to illustrate the net result which is cross-linking and chain cleavage.

Changes in Physical Properties of Plastics

Some of the more striking changes that occur when plastics are subjected to high energy radiation should be discussed. The data were taken to determine how these materials fail under radiation, and what radiation dose will cause failure. Each place where a transition period occurs in which an improvement is seen in some property will be pointed out. This discussion is not concerned with actual value of the radiation exposure, but only with relative values. The nvt numbers** designate the exposure to reactor radiation by giving the total number of thermal neutrons to pass through a square centimeter

** For the materials discussed here and the particular position used in the ORNL Graphite reactor, 10^{18} nvt (thermal) = 10^9 rep. One rep (roentgen equivalent physical) = approximately 100 ergs per cc. of these materials.

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of the material, which the rep numbers designate the exposure in energy absorbed.

POLYETHYLENE. Because it has the simplest basic chemical structure, and is easily obtained in pure form, more data has been gathered on the reaction of polyethylene with high-energy radiation than on any other plastic. We have learned much about what to expect of other plastics by what we know about polyethylene, and a convenient way of analyzing the data for any polymer is to compare it to polyethylene.

Polyethylene (see Figure 2) cross-links when subjected to high energy radiation and some unsaturation is produced. It becomes dark in color after prolonged irradiation, gives off large quantities of gas, and becomes hard and brittle. The stress-strain curves for several irradiation periods are shown in Figure 3. The breaking load increases slightly for the shorter irradiation periods, and the elastic modulus increase. The elongation falls off very fast, while the impact strength takes a sharp increase at the point where the stretching property has about disappeared. The radiation dose to damage this material beyond use is a relatively large one.

Polyethylene changes in two other ways which have been much publicized: the melting point increases, and it becomes clearer (or less hazy). The increase in melting point is due, of course, to the increase in molecular weight due to cross-linking. A point is reached where the material will decompose rather than melt. The decrease in haze can be most readily seen by the x-ray diffraction patterns shown in Figure 4. At the 2.4 x 10^{18} nvt exposure the two peaks designating crystallinity have completely disappeared. The material, which originally appeared to be a mixture of crystallites in an amorphous pool is now completely amorphous and, therefore, clearer.

NYLON. Nylon shows the same tendency to lose its crystallinity, and at about the same radiation dose (see Figure 4). The tendency for nylon to become clear is shown in Figure 5, where a brass rod was placed behind each specimen. Nylon also undergoes cross-linking, but does not harden or become brittle quite as fast as polyethylene. The stress-strain curves for nylon (see Figure 6) show an increase in tensile strength with a decrease in elongation as with polyethylene, but the strength is still increasing at the radiation dose where polyethylene has begun to lose strength.

POLYSTYRENE. The darkening that is shown in Figure 7 is essentially all of the change that has occurred in polystyrene for this relatively large dose of radiation, with the exception of an increase in melting point. This high resistance to radiation that is shown by polystyrene is partly due to the benzene ring in its structure. The benzene ring can be looked upon as an energy sink, and serves to protect the polymer. Polymers of polystyrene that have been modified (to give better impact strength, etc.) are fairly quickly changed back to their original condition.

PHENOLICS. Figure 8 shows an unfilled phenolic polymer. It also has the benzene ring in its structure, but in this case the ring is an integral part of the chain

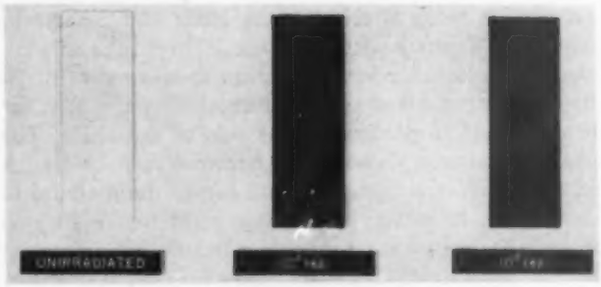

Fig. 10. Effect of radiation on vinyl chloride-acetate.

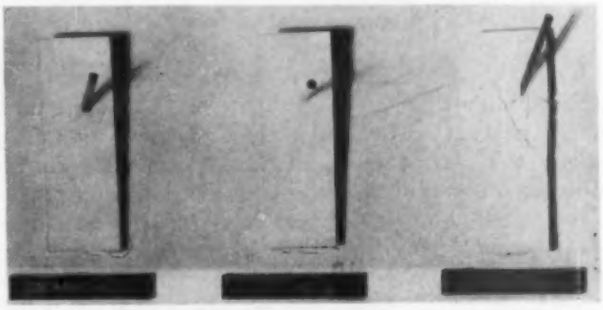

Fig. 11. Effect of radiation on Teflon.

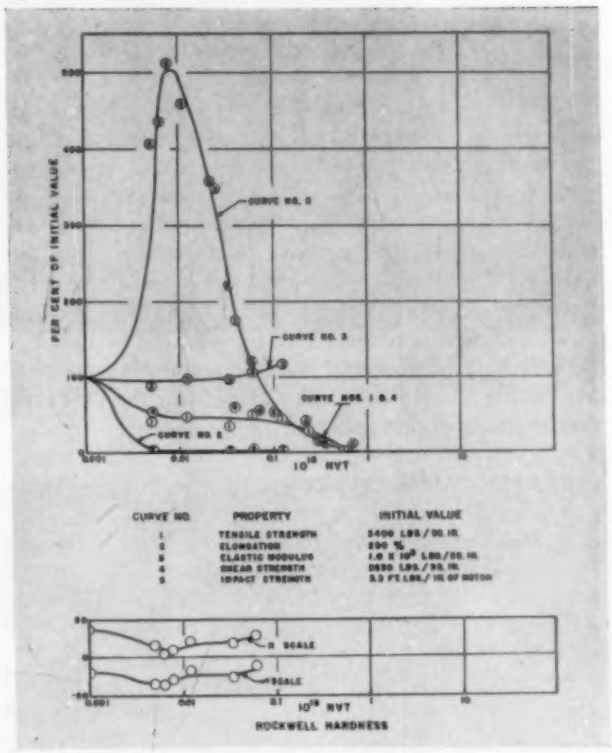
PER CENT OF INITIAL VALUE
CURVE NO. 5
CURVE NO. 3
CURVE NOS. 1 & 4
CURVE NO. 2
10^{18} NVT
CURVE NO. PROPERTY INITIAL VALUE
1 TENSILE STRENGTH 5400 LBS./SQ. IN.
2 ELONGATION 250 %
3 ELASTIC MODULUS 1.0 X 10^5 LBS./SQ. IN.
4 SHEAR STRENGTH 0850 LBS./SQ. IN.
5 IMPACT STRENGTH 3.5 FT. LBS./ IN. OF NOTCH
R SCALE
B SCALE
10^{18} NVT
ROCKWELL HARDNESS

Fig. 12. Property retention of polytetrafluoroethylene upon radiation.

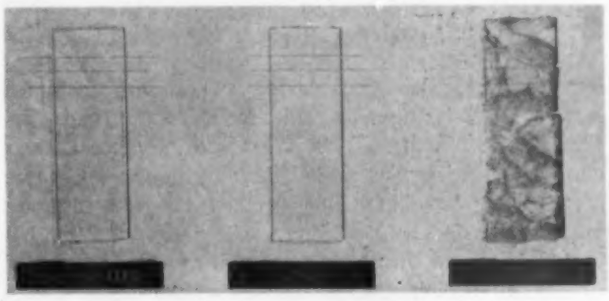

Fig. 13. Effect of radiation on cellulose nitrate.

rather than being attached to the chain like the styrene structure. Materials with the benzene ring in the polymer chain show much poorer radiation stability than materials like styrene and analine formaldehyde, where the benzene ring is attached to the side of the chain. The phenolic polymers swell and become very brittle. A soluble product is formed which causes the material to disintegrate in water. There is a point (see Figure 9) where the elongation property is somewhat improved but, in general, this material shows no improvement in any property at any irradiation period. The radiation resistance of phenolics, as with most hard plastics, can be improved by adding a mineral filler.

VINYL CHLORIDE-ACETATE. The most striking change in the vinyl chloride-acetate polymer is the very rapid darkening shown in Figure 10. The radiation dose that produces an opaque black color is of the order of 100 times less than that to change the properties of the other materials discussed thus far. Small blisters form which contain HCl. This material softens and shows a tremendous increase in elongation. This increase in elongation occurs much earlier than any appreciable change in hardness, and even much sooner than any great amount of darkening. The primary mechanism for the changes in vinyl chloride-acetate is chain cleavage.

TEFLON. Teflon (see Figure 11) shows no outward appearance of being changed, but the very rapid deterioration is quickly evident when a nail is punched through it. The radiation dose is very low even for organic materials. For very short irradiation periods, there is a very large increase in impact strength (see Figure 12) but even here the elongation has dropped to nearly zero, and the tensile strength has decreased about 50%. Fluorine is liberated by the reaction of radiation with Teflon, but much of the fluorine attacks the polymer before it can escape and accounts for the very rapid deterioration of this material.

CELLULOSICS. Cellulose nitrate (see Figure 13) is a typical example of what happens to a cellulose plastic in a radiation field. The saturated ring structure is very vulnerable and large quantities of gas are evolved: approximately 20 cc. per gram of material for the broken specimen shown. Failure is by chain cleavage.

POLYMETHYL METHACRYLATE. Polymethyl methacrylate, shown in Figure 14, also suffers very rapid deterioration due to chain cleavage. Here, again, large quantities of gas are evolved, though not as much as for cellulose nitrate. If polymethyl methacrylate is heated during or after irradiation, it will swell to look like a foam material.

ELASTOMERS. The elastomers exhibit much the same kind of changes by radiation as do the rigid plastics. As would be expected, they always lose their elastomeric properties although some harden and some soften when irradiated. Butyl rubber becomes soft and gummy due to chain cleavage, and natural rubber becomes hard and brittle by cross-linking. The properties of natural rubber change as one would expect for a rubber that is hardening, and the tensile strength,

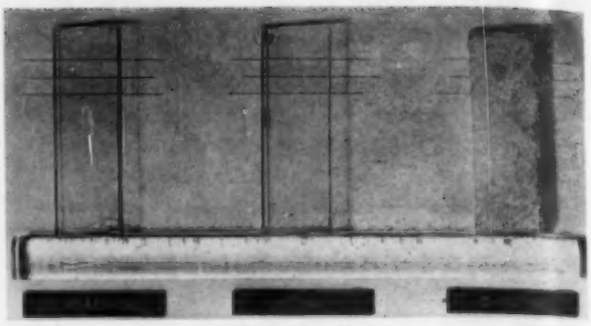

Fig. 14. Effect of radiation on Lucite.

elongation, and compression set are all decreased. When the rubber has become so hard that it is about like glass, there is a reversal in the tensile strength curve and a very rapid increase. Butyl rubber loses tensile strength and elongation and has a very large increase in compression set, as would be expected for a material that softens.

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—THE END

Acrylics Permit Intaglio Molding

The new "Adventurer" playing card set marketed by Brown & Bigelow, St. Paul, Minn., features a clear Plexiglas lid, silk screened on the under surface in a coral red, with an historic Colt's revolver molded in intaglio and decorated in gold and pearl. The cards themselves depict 16th Century pistols.

Plexiglas offers a smooth surface combined with a high degree of shatter-resistance. Its ease of molding permitted Hoosier Cardinal Corp., Evanston, Ind., to incorporate fine engraving detail in the revolver barrel and frame.

—THE END

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Isocyanates on the Way

The first full-scale production plant in America for the manufacture of isocyanate chemicals, being built by Mobay Chemical Co. at New Martinsville, W. Va., is now more than 40% complete and production should start in October, it was announced at a press conference on June 8. Construction is on a 200-acre site, and consists of 12 structures, including production facilities, office and service buildings, and research facilities.

Mobay will manufacture isocyanate and special polyester resins which are used in combination to produce urethanes in such forms as flexible and rigid foams, wire coatings, paints, new synthetic rubber formulations, and adhesives. In addition, Mobay will supply activators, modifiers, catalysts, and other chemical ingredients, as well as technical know-how and machinery for producing foam, but will manufacture no finished products. Formed last year by Monsanto Chemical Co., St. Louis, and Farbenfabriken Bayer, A.G., Leverkusen, Germany, Mobay has been supplying the industry with chemical raw materials from an interim plant at Anniston, Ala., supplemented by imports from Bayer.

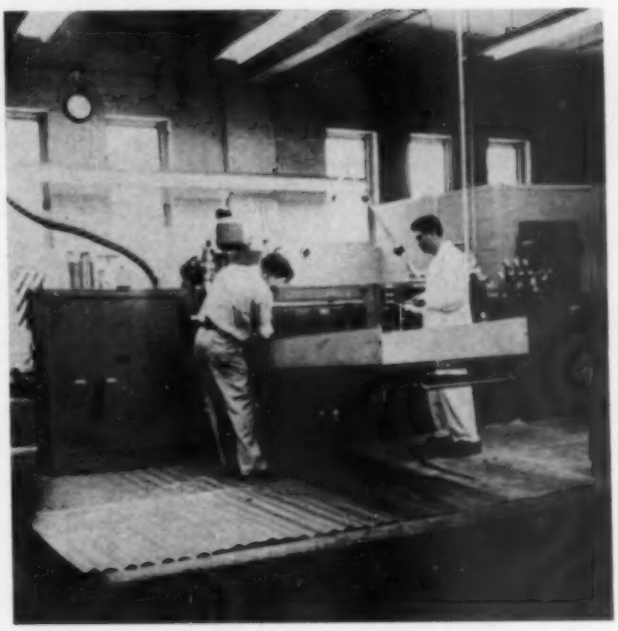
Licensees of Mobay for the manufacture of flexible foam include Dryden Rubber Division, Sheller Mfg. Corp.; Dunlop Tire & Rubber Corp.; Wm. T. Burnett & Co.; Goodyear Tire & Rubber Co.; Dayton Rubber Company; American-Collo Corp.; and Albert Trostel & Sons Co., Inc. Prior to the formation of Mobay, Bayer had licensed B. F. Goodrich Co., General Tire & Rubber Co., and Curtis-Wright Corp., and Mobay will carry on the work with these firms.

Machinery for producing foam, available to licensees, is critical since foaming action starts within three seconds after the chemicals are combined in the proper amounts, and the entire foaming action (amounting to an expansion of the original volume by 40 times) is completed in about 30 seconds. Without a properly controlled machine, foaming action would start within the machine itself.

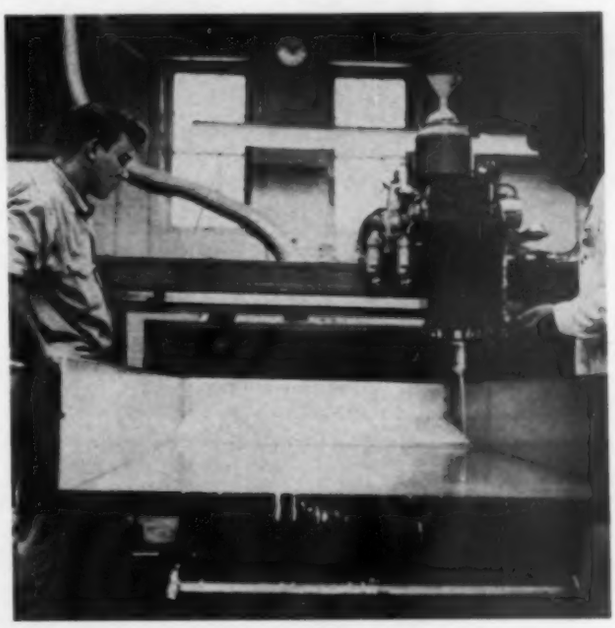
A variety of types and styles of machines are available to licensees, ranging from small, fixed-head units used for small sized molds to machines capable of making continuous-length blocks of foam 40 inches wide and nine inches thick. A batch unit machine for making foam is shown in operation in the accompanying photographs.

The flexible urethane foams are expected to be used in a wide range of products from powder puffs to carpet pads, and from seat cushions to clothing insulation. Varying from extremely soft to a very hard foam, the

(Continued on page 364)



Production of flexible urethane foam on a Mobay machine takes less than four minutes: A—Foaming machine before the start of the production run.



B—The mixing head moves across the mold which travels into the machine.

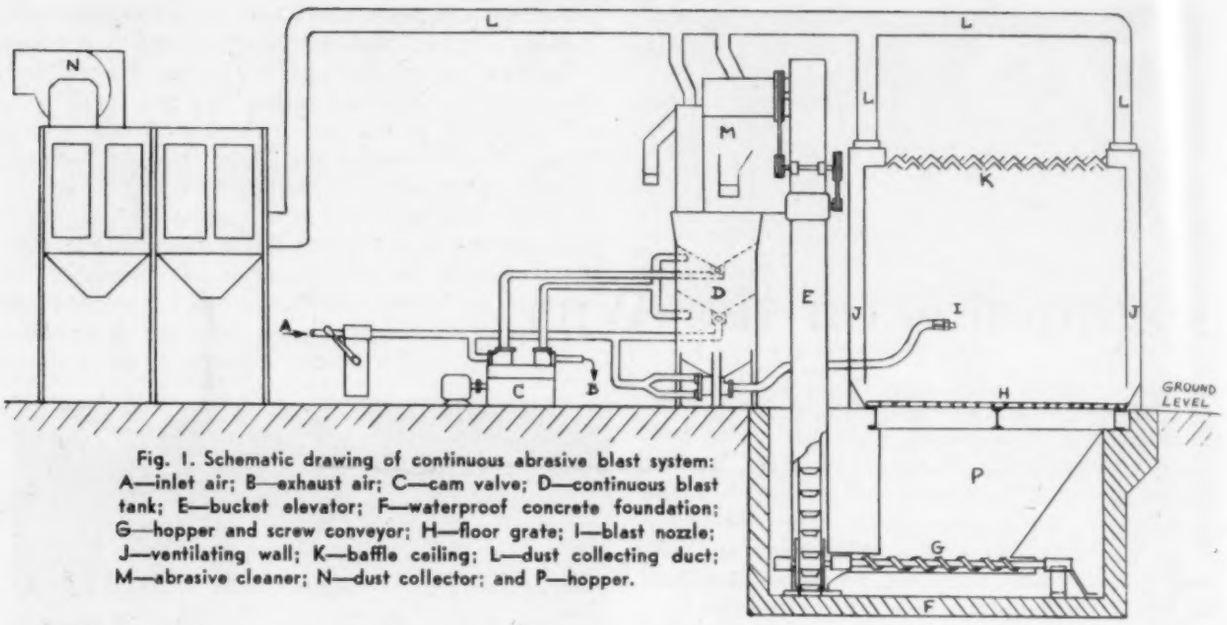


Fig. 1. Schematic drawing of continuous abrasive blast system: A—inlet air; B—exhaust air; C—cam valve; D—continuous blast tank; E—bucket elevator; F—waterproof concrete foundation; G—hopper and screw conveyor; H—floor grate; I—blast nozzle; J—ventilating wall; K—baffle ceiling; L—dust collecting duct; M—abrasive cleaner; N—dust collector; and P—hopper.

Surface Preparation of Reinforced Plastics for Bonding

Design, operation and advantages of a continuous abrasive blast system that gives improved inter-laminar bond strengths of laminates.

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and

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In order to increase production and decrease costs in the manufacture of bonded reinforced plastic assemblies, it was necessary to devise faster and better methods for preparing the surfaces of the reinforced plastic members prior to bonding them together. Previously, these surfaces had been prepared by roughing them with air- or electric-powered disc or belt sanders. Average production time was approximately 0.40 square foot of surface roughed per man-minute.

High cost of operating supplies was inherent in this operation due to the necessary expenditure of abrasive discs and belts. In addition, inter-laminar bond strengths were not always satisfactory. A large variation in bond strengths was encountered which, in some cases, resulted in failure of the inter-laminar bonds.

Thus, a need was apparent for a procedure which would offer the following three improvements over existing laminate surface preparation techniques prior to bonding:

(1) Decrease in direct labor cost of preparing surfaces.
(2) Lower cost of expendable operating supplies.
(3) Higher and more uniform inter-laminar bond strengths.

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Preliminary investigation indicated the use of an abrasive blast system as the logical means of accomplishing our purpose. Manufacturers of abrasive blast equipment were contacted and their recommendations as to types of equipment and processing techniques were studied and evaluated. Laboratory and pilot plant tests were conducted to evaluate the various types of equipment and abrasives available.

Abrasive Grit

A number of different types of abrasives were tried and the results evaluated and compared. A ferrous abrasive material, Duroblast G18, manufactured by the Steelblast Abrasive Company of Cleveland, Ohio, was found most satisfactory for the following reasons:

(1) Fast and efficient abrasion.
(2) Long effective abrasive life.
(3) Uniform and satisfactory inter-laminar bond strengths resulted.
(4) Low abrasive loss during processing.

Subsequent production experience has justified this selection.

Equipment Requirements

The following outline of processing requirements was prepared to guide our section of equipment:

(1) Capable of continuous operation.
(2) Low maintenance cost.
(3) Low cost of expendable supplies.
(4) Control and elimination of processing wastes.
(5) Versatility of equipment (able to accommodate various sizes and shapes of product to be abraded).
(6) Compatible with easy handling of product to be abraded.
(7) High productivity.
(8) High ratio of productivity to labor.

A continuous blast system was selected which met all of the above requirements. The manufacturer of this equipment, W. W. Sly Co., Cleveland, O., supervised its erection and aided materially in solving various minor operational problems which were encountered during the initial period of operation.

Description of Equipment

The continuous blast system can be best described in terms of its various components, all of which serve a specific function in the blast process and are shown in Figure 1.

Foundation

In order to permit the blast operation to be carried on at ground level, a waterproof concrete foundation was constructed below the ground level to act as a support for the blast room, and as a housing for the abrasive conveyor system. This foundation is identified as F in Figure 1.

Blast Room

The blast room is of double-wall construction, the inner panel being perforated to permit the removal of process dusts through the collecting ducts. A baffled ceiling permits the introduction of clean air, and a perforated floor allows spent abrasive to fall into the abrasive conveyor system.

Fig. 2. Interior view of blast room.

The blast room walls are identified in Figure 1 as J, the ceiling as K, the floor as H, and the dust removing ducts as L.

Two- by four-foot vestibules were built onto the entrance and exit openings of the blast room. These vestibules help to prevent the abrasive from being propelled outside the blast room. The room is approximately 10 feet square by 8 feet high, with a four-foot wide opening into each vestibule.

Rubber strips were hung in the blast room and vestibule openings to further act as seals for the blast room without hampering the flow of material into and out of the blast area. Two operators can be accommodated in the blast room which is well lighted by approximately 10 safety lamps swivel-mounted on the ceiling. An interior view of the blast room is shown in Figure 2, while an exterior end view is shown in Figure 3.

Abrasive Conveyor System

The hopper (P in Figure 1) to carry spent abrasive to the screw conveyor, the screw conveyor (G), and the lower section of the bucket conveyor (E) are located beneath the blast room floor level. The screw conveyor and the bucket conveyor are driven by a linked rubber-coated fabric belt operated by a drive pulley. The conveyor drive is located on top of the bucket conveyor shaft.

Abrasive Cleaner

The abrasive cleaner system (M in Figure 1), into which the buckets unload the abrasive, provides a

Fig. 3. Exterior end view of blast room showing vestibule and conveyor system (foreground), and blast tank with abrasive cleaner unit on top (extreme right).

chamber where dust and foreign particles are removed from the abrasive through the exhaust ducts (L) leading to the dust collector (X). Larger foreign matter which might clog the abrasive tank is taken out by means of a separator screen.

Abrasive Tank

The abrasive storage tank (D in Figure 1) contains the abrasive prior to its introduction into the blast hoses. The tank contains three compartments, the upper one of which is not pressurized. The lower compartments are pressurized. The upper and middle compartments are closed off from those compartments immediately below them by means of ball checks. The lower compartments are kept under pressure so that the abrasive is forced into the hose under pressure.

Because the top chamber must be at atmospheric pressure to admit the abrasive from the abrasive cleaning system, an electrically driven cam valve (C) is used to permit the abrasive to move from the non-pressurized compartment in the abrasive tank to the pressurized ones. At intervals, the cam valve closes off the intake air to the system and opens the tank compartments to the atmosphere for exhausting (B). During this time the ball check opens between the non-pressurized and the pressurized compartments, permitting the abrasive to flow into the pressurized chamber.

Dust Collecting System

This consists of a dust collecting cabinet, dust separator, screens, blower, and duct system. Dust removal is accomplished through the walls of the blast room and from the abrasive cleaning chamber as previously described.

Blast Hoses and Nozzles

The hose carries the regulated air and the abrasive into the blast room from the bottom of the abrasive tank through the nozzles (I in Figure 1) which are carbide orifices ⅜-inch in diameter.

Compressed Air System

The air system consists of a compressor with an adequate after-cooler, an air-water separator, and a pressure regulator. Air enters the blast unit system at point A in Figure 1.

In addition, a filter to remove oil from the air system is recommended, since the check valves in the blast tank are deteriorated by oil. Water is a deadly enemy of the abrasive grit used, causing it to rust together into large chunks which quickly clog the abrasive tank, hoses, and nozzles. Therefore, proper cooling of the air and removal of the condensate are required to prevent costly maintenance and loss of production time.

Approximately 200 cubic feet per minute of air is required to operate two ⅜-inch nozzles simultaneously at 60 psi. regulated air pressure.

Air Control Valve

A dual control is provided in order to regulate the flow of air into the hoses and tank. In addition to a quick-acting valve which can be used as an emergency control, a solenoid-operated valve is provided and controlled by manual triggers located next to the hose nozzles.

Product Conveyor

For most efficient production operation, a power conveyor should be used to maintain a regular flow of the product to be abraded into and out of the blast room. For our purposes, a three-foot wide variable-speed wire mesh conveyor, about 30 inches above floor level and controlled either by the operator or from outside the blast room, is currently being used.

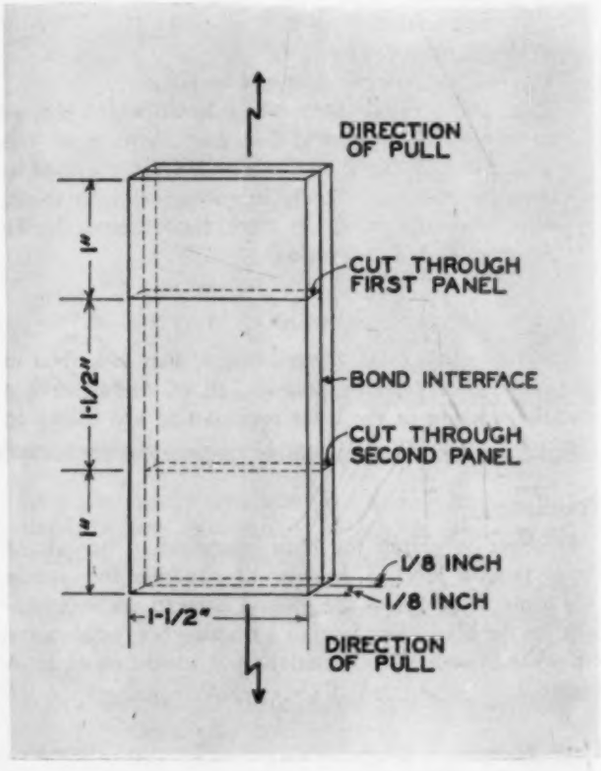

Fig. 4. Drawing of test specimen to determine inter-laminar bond strengths.

Table 1. Comparative Inter-Laminar Bond Strengths of Laminates Made With Bond Faces Prepared by Sanding and by Blasting. (Bond area, 2.25 sq. in.; bond pressure, approx. 0.2 psi.)

Sample No.	Ultimate Shear, lbs.		% Improvement by Blasted Surfaces
	Sanded Surfaces	Blasted Surfaces	
1	535	900	—
2	600	900	—
3	900	1,000	—
4	900	1,100	—
5	950	1,100	—
6	1,025	1,100	—
7	1,100	1,150	—
8	1,175	1,500	—
Average	898	1,094	22
Mean	925	1,100	19
High	1,175	1,500	68
Low	535	900	28
% Average deviation from mean	18%	11%	64

Protective Clothing

While working inside the blast room, the operator must be protected from the abrasive grit which travels at high velocity and from the dust resulting from the abrasion of the product. Heavy woolen trousers and long-sleeved woolen shirts are recommended items of clothing. A helmet with safety glass face plate and an air intake to provide clean, dry air at low pressure to the operator is also necessary. The operator should wear gloves to protect his hands from the abrasive grit.

Continuous Blast Process

Although the description of equipment is probably sufficient to define the operations of the unit, a brief process outline is included to give a clear picture of the continuity of operations.

The abrasive grit located in the tank is forced into the blast hose and into the air stream which enters the system from the compressor. This air carries the abrasive through the hose and out the nozzle which is directed toward the material to be abraded. Spent abrasive drops through the floor plate in the blast room and into the collecting hopper, from where it is carried by a screw conveyor to a bucket elevator and then into the abrasive cleaner unit where dust and odd-sized particles are removed. The abrasive grit then is returned by gravity into the abrasive tank, and the cycle is repeated.

From between the double walls of the blast room and abrasive cleaner, ducts carry dust to a collecting unit. Clean air is continually drawn into the blast room through the baffle plates in the ceiling.

Comparison of Processes

The following comparison between the present method of abrasion and the previous method, which consisted of sanding surfaces prior to bonding, demonstrates the advantages inherent in the continuous blast system.

Cost of Supplies

The savings effected by use of the continuous blast system, due to eliminating expenditures for sanding discs, sanding belts, etc., amounts to approximately one cent per square foot of abraded surface.

Cost of Direct Labor

Average production rates, exclusive of materials handling, are presently running about 0.7 man-minute per square foot as compared with 2.5 man-minute per square foot obtained by previous abrading methods. This provides a saving of 1.8 man-minutes per square foot.

Productivity

The continuous blast equipment is presently capable of providing 170 square feet per hour of abraded surface on relatively complex shapes, and on widely varying product sizes being run simultaneously through the same system. On uniform products and/or simpler shapes, a higher rate of production could be expected.

With previous abrading methods, a single operator was able to produce only about 24 square feet per hour of abraded surface. With these methods, therefore, five operators would be required to obtain production rate equal to that of the continuous blast system. It is interesting to note that the floor space requirements for maximum productivity are about equal for both methods, with the blast system providing a much more efficient method of product handling.

Equipment Operating Cost

We are unable to obtain exact comparative figures for the two systems relative to the costs of electricity, water, etc. A reasonable comparison indicates an increased operating cost of approximately $0.003 per square foot for the abrasive blast system. However, we feel certain that this will be more than offset by the decreased cost of maintaining power sanding equipment, and the lower costs of purchasing and replacing the protective equipment and supplies.

(Continued on page 364)

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Plastics as Capacitor Dielectrics—4. Mylar

The fourth of a five-part series on plastics being used as dielectrics or insulators in the electrical industry.

The synthetic plastics industry has given the design engineer several amazing materials to evaluate in recent years. Other materials have existed in the laboratory for dozens of years before they were "discovered" and brought forward in a more refined and useable state. Typical examples are polystyrene and polyethylene.

The demands of the product designer are dictated by the continued increase in the severity of operating conditions of components. Consequently, the plastics industry has spurred its search for new materials and reevaluated some laboratory developments which have been shelved.

Polyethylene terephthalate (Dupont's trade name is Mylar; in Britain the name is Terylene) is a condensation product of terephthalic acid and ethylene glycol. This polyester material was formulated several years ago and, at that time, an unusual balance of physical and electrical characteristics was observed over a very wide temperature range. The plastics industry developed methods of processing this material, partly as a result of military needs for a capacitor dielectric for higher operating temperatures.

Like all new materials, there are some characteristics exhibited by Mylar which are not yet understood. One such characteristic is the effect of the heat on certain lots of the material wherein minute crystals appear on the surface of the film. These crystals and inclusions sometimes are visible, and at other times are easily observed under polarized light through a low-power microscope. However, evidence in the laboratory has shown that these minute inclusions and crystals are not necessarily detrimental spots since dielectric voltage breakdowns occurred also at unsuspected parts of the film.

The exceptional physical, chemical and electrical properties of Mylar lend themselves to a wide variety of uses from capacitor dielectrics (see Figure 1) to sound recording tapes, and metallic yarn for the clothing industry. In order to find why there is such a rapidly increasing interest in this polymer as a capacitor dielectric we must first observe some of its exceptional properties.

Thermal Properties

The temperature range of military capacitors extends from –70 to over 150° C., a service range which Mylar dielectric can easily fill since it remains quite flexible and does not expand appreciably with temperature. Its maximum temperature may be over 200° C., since capacitor units have been life-tested at this temperature, and its melting point is approximately 250° C. Film heated to 150° C. will shrink 3-5%.

Condenser Products engineers have found that heat curing of roll-wound capacitor units at 230-250° C. for 2-10 minutes will weld the edgespaces of the Mylar section and shrink the outer layer of wrap to produce a final unit which can be used without enclosing in any protective case. In tests performed at high humidity, these units did not deteriorate in insulation resistance or break down under voltage stress. In special instances when end sealants of phenolic or epoxy resins were used where the wire leads entered the wound rolls, a unit resulted which was capable of passing military waterdip tests.

However, excessive heating at temperatures over 150° C. will cause embrittlement of Mylar and reduction of its physical properties. Also, the material will hydrolize in the presence of moisture and high temper-

ature. Thus, it is important to exclude moisture from a Mylar capacitor when subjecting it to very high temperatures. Special processing to exclude moisture was developed by heating the capacitor in vacuo and hermetically sealing it. When impregnated with very low moisture content dimethyl silicone, Mylar capacitor units showed extremely good resistance to embrittlement.

Physical Properties

In order that extremely thin films (in the order of 0.0001-inch thick) be made for winding capacitors, the film or tape must have high tensile strength, tear strength, and flex life.

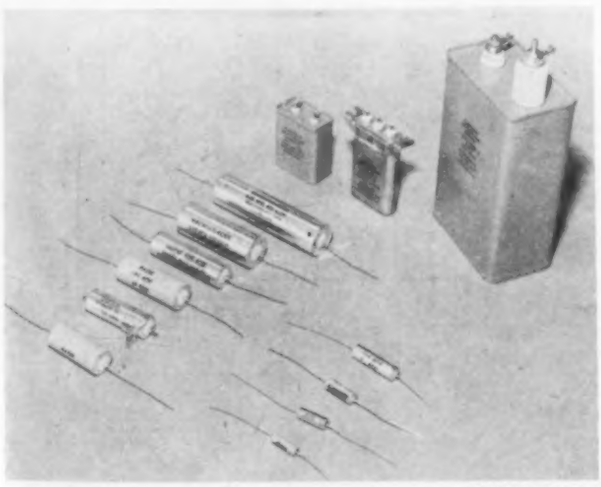
Mylar polyester film, made presently in sizes from 0.00025-0.0075 inch thick, is one of the strongest plastics known, with a tensile strength equal to that of hard aluminum. Its flex life and tear strength are surpassed only by that of polyethylene film. These physical properties are not appreciably affected by temperatures from -70 to +150° C., and Mylar retains useful properties to 180° C. The winding of Mylar film between layers of aluminum foil to make capacitors is shown in Figure 2.

Chemical Properties

It has been mentioned that Mylar is susceptible to moisture when in an enclosed container at high temperatures. Nevertheless, it absorbs less than 0.3% moisture when immersed in water for one week at room temperature.

Mylar is only 20 times as permeable to water vapor as moisture-proof cellophane is, and 40 times as impermeable as cellulose acetate in capacitor dielectrics. Compared with acetate or paper, therefore, relatively little heat and vacuum processing are required to eliminate moisture from a Mylar film capacitor before it is hermetically sealed.

The plastic is highly resistant to attack by bacteria and fungus growths. This is a feature worth noting in those instances where the capacitor is used in equipment that is subject to such attack.



"PICS Chicago"

Fig. 1. Typical capacitors made with Mylar dielectric. Smallest unit is 0.0068 microfarad, 400 volt capacitor which is 11/16-inch long and 0.235-inch in diameter; largest capacitor in rectangular can is 0.5 microfarad, 7,500 volt unit.

"PICS Chicago"

Fig. 2. Winding four layers of Mylar between aluminum foil. Number of layers of dielectric used depends on capacitor rating.

Phenols will degrade the physical and electrical properties of Mylar, so that caution must be used in those instances where phenols are employed as sealants and encapsulating mediums which come in contact with the Mylar. In general, Mylar is quite resistant to dimethyl silicone, hydrocarbon oils, solvents, and electrical varnishes commonly used in transformers.

When heated for 1,000 hours in silicone 50 CTSK fluid at 125° C., Mylar shows a slight decrease in tensile strength and a doubling of its percent elongation.

Electrical Properties

Unless otherwise stated, the Mylar referred to hereinafter is type "C" film, 0.00025-0.001 inch thick, which is used exclusively as a capacitor dielectric where high temperature insulation resistance is of primary importance. Type "A" film, although as good a dielectric as type "C" film, has been found to have a lower insulation resistance at high temperatures, although prolonged heat processing was found to alleviate this undesirable property to some extent.

Mylar polyester is a material of intermingled amorphous and crystalline regions, and prolonged heat curing at high temperatures (up to 220° C.) has been found to improve its electrical properties such as power factor, percent capacitance change with temperature, and dielectric strength. Prolonged heating may alter these regions and cause greater crystallinity and improvement of electrical properties. Another theory states that improvement of electrical properties is due to disorientation of the oriented film by prolonged heating.

The electrical characteristics of Mylar are quite complex, and it is generally agreed that three AC dielectric processes are evident and associated with various

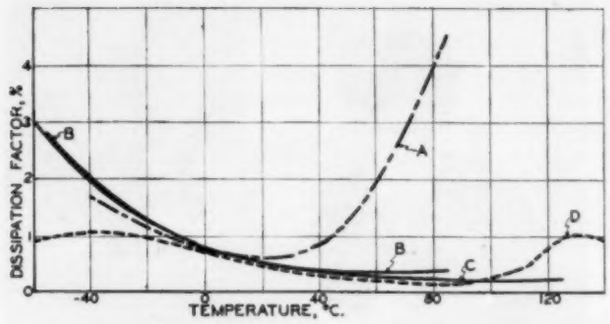


Fig. 3. Effect of temperature on dissipation factor at one kilocycle: A—Halowax-impregnated paper; B—mineral oil-impregnated paper; C—silicone-impregnated paper; and D—unimpregnated or silicone-impregnated Mylar.

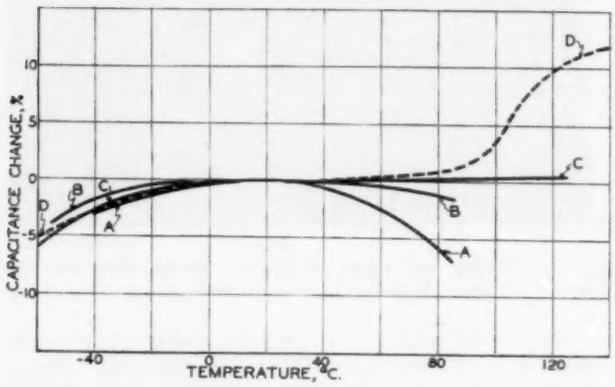


Fig. 4. Effect of temperature on percent capacitance change (from the 25° C. value) at one kilocycle: A—Halowax-impregnated paper; B—mineral oil-impregnated paper; C—silicone-impregnated paper; and D—unimpregnated or silicone-impregnated Mylar.

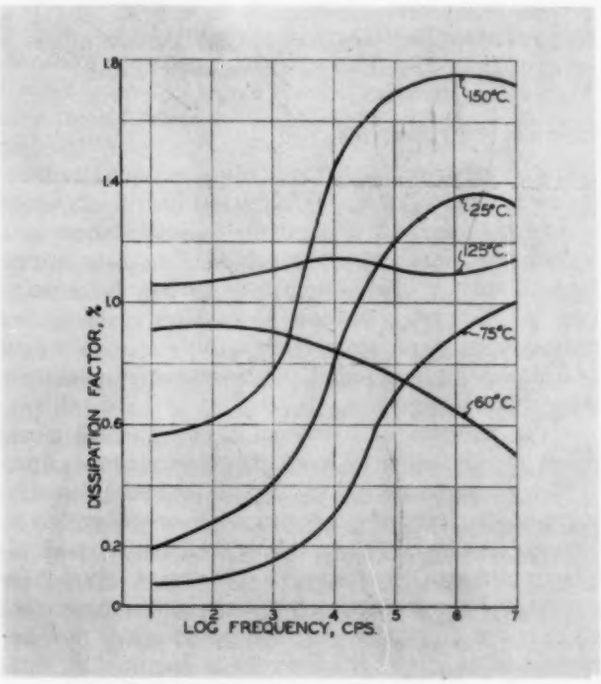


Fig. 5. Effect of frequency (logarithmic) on dissipation factor (%) of Mylar at various constant temperatures.

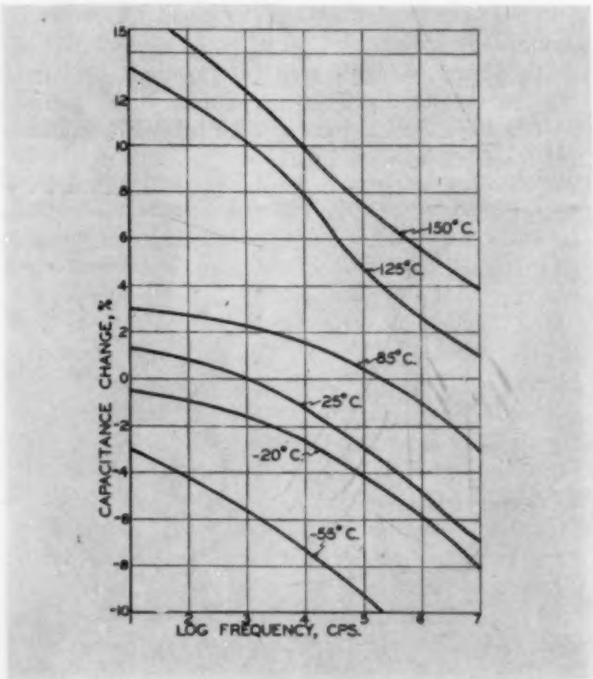


Fig. 6. Effect of frequency (logarithmic) on capacitance change of Mylar at various constant temperatures.

degrees of water content and crystallinity of the polyester film.

One process depends upon the thermal and mechanical properties of the Mylar, and is probably due to the relaxation of the dipoles in the polymer chains. Another process is due to hydroxyl groups, while the third process is effective at frequencies to one kilocycle and high temperatures (210° C.) where there is actual conduction of charge through the dielectric material.

Since these complex processes occur, it may be well to note the individual effects of temperature and frequency on dielectric constant, power factor, insulation resistance, and other characteristics of thin Mylar films.

Temperature Effects

The capacitance of Mylar changes considerably with higher temperatures and frequencies. At lower frequencies and near room temperature, these characteristics are comparable to or even better in some instances than those of impregnated paper dielectrics.

The effects of short-time and prolonged heating on power factor at temperatures beyond 130° C. are quite pronounced. Unimpregnated and dimethyl silicone-impregnated units were heat treated at 170° C. for two hours. The one-kilocycle power factor at temperatures from 25-125° C. was improved by 15%. However, units exposed to 170° C. for 1,500 hours experienced a power factor improvement of 50% over the temperature range 25-190° C. Below room temperature, these improvements are slight.

Similarly, extended heat treatment was found to improve the temperature coefficient of capacitance by approximately the same percentage. For instance, at 125° C. and one kilocycle, the capacitance of Mylar units, both impregnated and unimpregnated, increases 12%

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over room temperature capacitance. After maintaining the units at 170° C. for 1,500 hours, capacitance at 125° C. increases 4% relative to the 25° C. capacitance and appears to level off beyond 175° C.

Just as in the case of polyethylene and cellulose acetate dielectrics in parallel, Mylar can be paralleled with Styroflex to produce any desired percent change of capacitance in any specified temperature range. For instance, Condenser Products engineers combined a certain ratio of Mylar capacitance with another of Styroflex to produce a capacitor which changed less than 0.30% in the 25-85° C. range. This figure contrasts markedly with the larger value of +0.90% change for Mylar alone, or −0.70% for polystyrene alone.

Figure 3 shows the effect of temperature on dissipation factor (which is equivalent to power factor not in percent) for Mylar units at one kilocycle as compared with paper impregnated with Halowax, mineral oil, and silicone fluid. The largest power factor figure for Mylar is approximately 1% which occurs at −40 and +125° C. The maximum value at 125° C. decreases with exposure to heat treating temperatures over 125° C., and this change is permanent.

The change in capacitance from room temperature capacitance at one kilocycle also depends upon heat treatment time. Units heat treated at 170° C. develop maximum advantages after two hours of heating. Units heated at 170° C. for 1,000 hours continued to improve their temperature coefficient, but the improvement was negligible for operating temperature ranges of −60 to +100° C. Figure 4, illustrating change in capacitance with temperature, shows the radical increase in capacitance beyond 100° C. for Mylar, whereas paper impregnated with silicone fluid has a much smaller change over the range of temperature shown.

Frequency Effects

While previous values of power factor and capacitance were referred to a frequency of one kilocycle, these values are affected considerably by frequency. In general, the power factor at all temperatures increases with an increase with frequency to one megacycle, except that power factor decreases at temperatures below −65° C. with an increase of frequency. Also, power factor decreases at all temperatures with frequencies above 10 megacycles.

As Figure 5 shows, power factor is at a minimum at 75° C. for all frequencies from 60 cycles per second to one megacycle. As the temperature decreases from 75° C., the power factor again approaches a maximum near −50° C. in this frequency range. Also, as the temperature increases above 75° C., another power factor maximum is attained near 125° C. Below −50 and above 125° C., the power factor decreases in this frequency range.

As a rule, the dielectric constant and, correspondingly, the capacitance increases with decreasing frequency and increasing temperature. The dielectric constant of Mylar is between 2.7 and 3.5, depending upon frequency and temperature. These values of dielectric constant lie between the high quality dielectrics, such as polystyrene and Teflon, and the higher dielectric constant dielectrics, such as paper and cellulose acetate. Figure 6 shows how the frequency affects the capacitance at several constant temperatures when referred to the capacitance at 1,000 cycles and 25° C.

Insulation Resistance

The volume resistivity of Mylar film is approximately 10^{19} ohm-centimeters at room temperature. This value

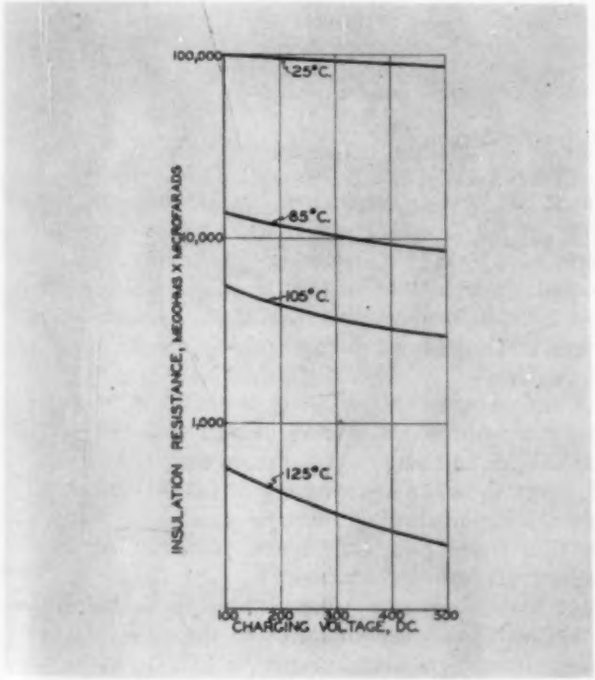

Fig. 7. Effect of applied charging voltage (DC) on insulation resistance (megohms x microfarads) of 0.5-mil unimpregnated Mylar at various constant temperatures. Charging time = two minutes for each voltage.

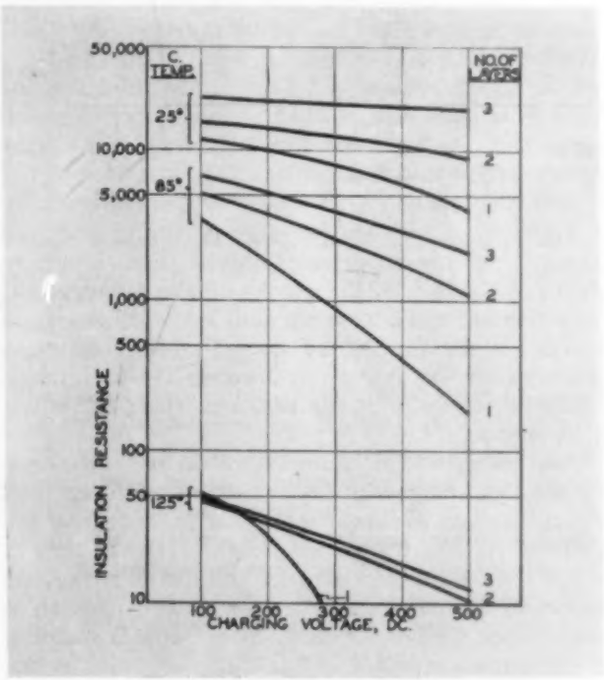

Fig. 8. Effect of applied charging voltage (DC) on insulation resistance (megohms x microfarads) of 0.35-mil silicone-impregnated Mylar at various constant temperatures. Charging time = two minutes for each voltage.

"PICS Chicago"

Fig. 9. Mr. Mistic conducts insulation resistance test on molded Mylar capacitor to measure leakage of unit. Shielded section where capacitor is connected is open for photographic purposes.

places Mylar's resistivity above polyethylene's and very nearly as high as those of polystyrene, Kel-F, and Teflon. However, there are several factors which affect the volume resistivity and, consequently, the insulation resistance of Mylar capacitor units whether impregnated or unimpregnated. These factors are applied voltage, time of application (electrification period), temperature, and film thickness.

Insulation resistance is inversely proportional to the voltage gradient for any film thickness. Also, as shown in Figure 7, the insulation resistance, in megohms x microfarads, is affected appreciably by temperature. Over 125° C., the applied voltage affects thin films much more than thicker films. Unimpregnated Mylar units made with 25-gage film have approximately 50% lower insulation resistance with temperature than units made of 50-gage film.

When Mylar is impregnated with silicone fluid for use at higher volts-per-mil loading, the insulation resistance is materially reduced although the effects of temperature, voltage, and film thickness parallel those of dry section Mylar capacitors.

Insulation resistance, in megohms x microfarads, as a function of voltage for various temperatures of dimethyl silicone-impregnated Mylar film layers is shown in Figure 8. As the number of layers is increased, insulation resistance increases until a total thickness of one mil is attained. At this level, further increases in thickness do not appreciably increase the logarithmic insulation resistance at any particular charging voltage or temperature.

Another method of measuring insulation resistance is the self-time constant method, wherein a unit is charged and allowed to discharge through its own internal resistance. At 20° C., an unimpregnated unit (using a single layer of 35-gage film for the dielectric) has an insulation resistance well over one million megohm x microfarads. This value decreases to 500,000 megohm x microfarads at 85° C. when using 100 volts as the initial charge voltage.

Figure 9 shows a test for insulation resistance of a Mylar capacitor by measuring leakage current when a known voltage is applied.

Dielectric Absorption

Voltage build-up on the terminals of a discharged Mylar capacitor depends on charge time, discharge time, time after discharge, temperature, and voltage gradient. Obviously, this phenomenon cannot be explained away easily. Investigators of this characteristic have compared their results with others who have used different dielectrics but the same experimental procedure.

For instance, Table 1 gives data for several dielectrics on the percent of the initial charging voltage remaining 30 seconds after removing a shorting bar which discharged for one second a potential of 100 volts, applied for one minute to a Mylar dielectric unit at 25° C. Polystyrene has the lowest soakage, followed by polyethylene and Mylar.

Table 1. Charging Voltage Remaining after Shorting

Polystyrene	0.03%
Polyethylene	0.04
Mylar	0.2
Mica	0.8
Paper and mineral oil	2.0

The maximum percentage absorption value for Mylar, however, is approximately two to three times the 30-second value shown, or 0.4—0.5%. This maximum value depends upon the temperature of the dielectric. For practical purposes, at temperatures to 85° C. the maximum percent absorption is three times the value shown in the table.

For charge voltages to 500 volts, the time to reach the maximum varies from less than one hour at 25° C. to several hours at 85° C. or above. Using a one-minute charging time and a one-second discharge time, the logarithmic maximum percent absorption increases linearly with temperature, being 0.1% at 0° C., 1.0% at 40° C., and approximately 10% at 100° C.

Dielectric Strength

A single thickness of one-mil Mylar polyester film has a DC voltage breakdown strength of 5,000-6,000 volts per mil. A short exposure to heat treating temperatures of 170-210° C. does not materially affect the breakdown strength. However, exposures of more than two hours at temperatures over 200° C. materially reduces the breakdown strength owing to embrittlement of the film.

Unimpregnated Mylar units wound with 100-gage film can withstand a loading of 650 volts per mil at 125° C. for 250 hours without more than 10% failures. However, to yield a capacitor life of 1,000-10,000 hours, this volt-per-mil loading must be derated according to the fifth power rule, and rerated to meet civilian and military life-test specifications.

At lower operating temperatures, the volts-per-mil rating increases when subjected to the same 250-hour life-test conditions stated above. At 85° C., Mylar can sustain a stress of 1,200 vpm. for 250 hours. Here, again, proper derating is necessary for a longer life at this temperature. Displacing air in a Mylar section with synthetic fluids will yield higher volts-per-mil loading,

in some instances doubling the safe working voltage for the same capacitor life at the sacrifice of several other desirable characteristics, such as decreased insulation resistance.

Silicone fluid impregnation of Mylar units also increases the AC operating voltage by either increasing the voltage at which corona begins or entirely inhibiting corona. Without impregnation, a Mylar unit has only moderate resistance to corona. Although the 60-cycle rapid rise to breakdown strength is almost 5,000 vpm. in air, corona will occur at approximately 400 volts rms.

The capacitor will last for a length of time depending upon the thickness of the dielectric and the volts-per-mil loading. Corona will not harm the dielectric if it is operated below 400 vpm. for a one-mil dry sample; below 300 vpm. for a two-mil sample; below 120 vpm. for a six-mil sample; and below 30 vpm. for a 100-mil sample. Above these corona threshold voltages, a unit will last from a few minutes to somewhere near 500 hours, depending largely upon the volts-per-mil applied.

Applications

Mylar capacitors, both impregnated and dry, have found use in applications where paper, ceramic, mica, and glass capacitors formerly have been used. Such applications are found in radio and television circuits as coupling and bypass condensers. Where the ambient temperature is over 100° C., Mylar units work quite well.

In applications where small size, high operating voltage, and high insulation resistance are required, silicone and other synthetic impregnants are used with Mylar. High voltage, low current power supplies operating at 125° C. or higher require filter capacitors that have small size, low leakage current, and long life at high temperature. Mylar is quite well suited and economical for these applications.

As previously mentioned, Mylar-polystyrene units can be matched to yield any desired temperature coefficient to 85° C.

Although Mylar has a somewhat larger power factor than some impregnated paper units and mica, this fact is not detrimental to all normal circuit applications of frequencies to 10 megacycles where a small power loss can be tolerated. In this instance, Mylar can replace mica and paper capacitors.

Mylar can be metallized readily, and considerable research is being undertaken to utilize metallized Mylar dielectrics for component miniaturization.

Conclusions

In those applications where high resistance over a large temperature range is needed, or small size, high resistance, and high working voltages at high temperatures are required, Mylar polyester film is most efficient and economical. Where a small capacitance change over a wide temperature range is required, Mylar is superior to paper and may well become its chief contender in the field of dielectrics for capacitors.

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—THE END

Stress Cracking (Crazing) of Polystyrene—Part I.

(Continued from page 344)

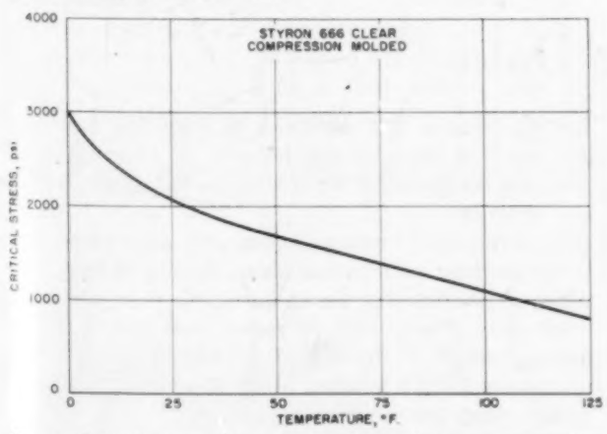

Fig. 4. Critical stress shows crazing dependent on temperature

to the tensile stress, and the fracture when it occurs is of a fibrous type (4, 5, 9).

Temperature Dependence

The variation of polystyrene's critical stress in air or water over a wide temperature range is shown in Figure 4. Above the freezing point of water, the time required to reach minimum equilibrium elongation is inversely proportional to the temperature (10). It is expected that the critical stress would continue to drop with increase of temperature until the ultimate elongation of the material would rise as it softens near its heat distortion point. Above this temperature, critical stress has no practical significance.

Stress Crack "Healing"

The rather limited work on healing of visible stress

(Continued on page 364)

Photos by United States Rubber Company

Guest Editorial

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Research and Development
Naugatuck Chemical Division,
United States Rubber Company
Naugatuck, Conn.

The Need for Engineering Data

The plastics industry is still a rookie. It is batting in a league against wood, stone, ceramics, and metals which have several thousand years of seniority. On the opposing battery are crafty old veterans with centuries of experience. If our hero is to stay in the big leagues, we must limit his strike-outs to the warm-up games before the paying customers start to complain.

There are many ways for a rookie to learn: from books, schools, laboratories, practice, trial and error, successes and failures, and from observation of his more experienced rivals. Our rookie must use each of these ways if he is to succeed, even to the extent of publicizing his failures. We are quick to publicize success. If we also will describe our failures, in technical rather than the lay journals, the rest of the industry can avoid our mistakes.

Unfortunately books, schools, and laboratories have too little basic information about the engineering properties of plastics. For the moment, we must overdesign every new plastic part to make sure that it will be strong enough to survive. Such overdesigning almost always results in a product which costs more, pound for pound, than the material it replaces.

Underdesigning for lower cost and the try-anything

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attitude have seriously hurt the industry. Everyone knows of a few, perhaps many, such horrible examples. It is less well appreciated that overdesign and a reluctance to use an unproven material are also retarding the normal growth of the industry.

Underdesign is being attacked with some success by industry committees and by discriminating customers. Overdesign, or excessive caution, can be corrected only by obtaining much more data on the engineering properties of plastics. Over the centuries, carpenters have learned how much or how little to expect from a wooden structure. Engineers' handbooks give the structural properties of steel, concrete, and other materials, and data has been acquired over several decades of experience. But where can the engineer turn when he needs similar data on plastics?

Our industry needs to accumulate such data rapidly if it is to expand beyond specialty and decorative products. Starts have been made in gathering this data. The Plastic Pipe Extruders' Committee of SPI has a project going at Battelle Institute which eventually should answer current questions about creep, effective tensile, burst strength, and long-term durability of plastic pipe. Consumer groups representing the gas and oil industries, sanitation engineers and corrosion engineers, with the help of plastics suppliers, also are beginning to obtain factual data about plastic pipe. These are all steps in the right direction, but we simply need to step farther and faster.

The plastics materials manufacturers' group of the

"Let us enlist the aid of the engineering schools in adding plastics to their curricula and promulgating a plastics engineering handbook as a cooperative endeavor."

"Where can the engineer turn to find design and property data similar to that given for steel, concrete, and other materials in the various engineering handbooks?"

MCA has for several years sponsored a project on plastics at MIT. Some of the objectives have been to define the behavior of plastics under mechanical load; to predict behavior under a wide range of conditions; and to provide a sounder basis for comparing plastics with each other and with other materials. The aircraft and automotive industries, the Armed Forces, and a number of SPI industry committees all are beginning to accumulate similar data. More steps in the right direction, but we still have a long way to go to overcome a thousand-year lead.

Every engineering school teaches its students the properties of wood, metals, and concrete. Why not of plastics? Architectural schools are beginning to feature plastics for decorative value. Why not for structural properties? The answer is simple: neither they nor we know precisely what these properties are.

Let us enlist the aid of these schools. Let us, collectively and individually, use our influence, and perhaps our money, to urge that engineering and architectural schools add plastics to their curricula. Let each student measure a plastics property or two and our plastics engineers' handbook, in the sense of engineering properties, will come into being.

Let our goal be more measurement of engineering properties of plastics from the smallest bolt to the largest beam, and from a film to a wall panel. Once properties are known, uses and improvements will follow inevitably.

—The End

Surface Preparation of Reinforced Plastics for Bonding
(Continued from page 355)

Summary of Economic Considerations

If an average labor payment rate of $1.60 per hour is assumed, it can be seen that the direct labor savings alone at full production (eight hours a day) would completely amortize the cost of equipment and installation of a continuous blast system in about 300 working days. In practically all cases, such a consideration would justify the addition of a continuous blasting abrasive system.

Non-Economic Considerations

From a standpoint of product quality the use of the continuous blast abrasive system results in structurally superior bonded joints. Comparative tests in shear strengths of bonded joints between laminate samples prepared prior to bonding by sanding and by shot blasting are given in Table 1.

The tests consisted of subjecting test specimens having 2¼ square inches of bonded interface to a vertical tensile pull in order to evaluate the strengths required to shear the bonds. The test specimen used is shown in Figure 4.

As can be seen, the panels whose surfaces had been shot-blasted prior to bonding gave superior and more uniform results. Better uniformity is demonstrated by the 64% improvement in the average deviation from the mean in the test results.

The increased bond strength is a direct result of the great increase in surface area of the plastic part obtained by the blast process as compared with previous methods of abrasion (see Figure 5).

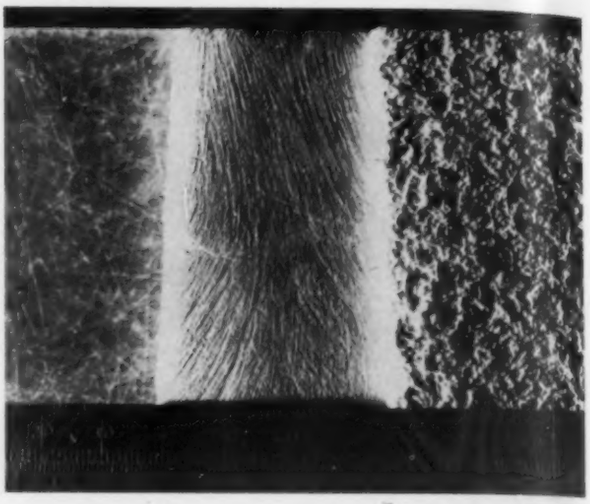

Fig. 5. Effects of sanding and blasting on surface area of a laminate: (left) typical molded laminate surface; (center) same surface after sanding with electric, rotary, 40-grit disc sander; and (right) surface of same laminate after abrasion in continuous blast system. (Magnification—2.4X).

Summary and Conclusions

Where a large amount of preparation of laminate surface prior to contact or low pressure bonding is necessary, we feel that the use of a continuous blast abrading system is justified from both the economic and quality standpoints. There seems little doubt in our minds that continuous abrasive blasting will become a standard part of low pressure laminate assembly unit operations.

—The End

Stress Cracking (Crazing) of Polystyrene—Part I.
(Continued from page 361)

cracks done in our laboratory confirms previous work reported in the literature (1, 9, 10, 11).

It seems generally agreed that stress cracks tend to disappear with time after removal of stress when stored at some elevated temperature. Internal and external stress cracking in injection and compression molded specimens did not heal visibly in 1,000 hours at 75° F. with test bars crazed in air, in methanol, and in normal heptane. At 170° F., however, the visible healing which took place within 100 hours was noticeable and, within 600 hours, was nearly complete. Unfortunately, little or no mechanical strength was regained, so that the only beneficial effects were in the visual appearance of the moldings.

It is well known that polystyrene moldings stressed in pure compression do not stress crack. Repeated and prolonged compressive stress on previously stress cracked moldings is effective in visual healing, but ineffective in restoring original mechanical strength.

Exposure of similar moldings at a temperature just above the second-order transition point (that is, at 185° F.) resulted in visible healing within 24 hours. In many cases, visible healing was complete within 100 hours and was accompanied by an appreciable regain of mechanical strength. Unfortunately, exposure of most moldings of regular polystyrene to 185° F. for any length of time results in such objectionable deformation as to render the treatment relatively useless from a practical standpoint.

(To be concluded in August)

Isocyanates on the Way
(Continued from page 351)

materials have regulated "bounce-back" after compression, a broad range of density, mechanical toughness, ability to be sewn by hand or machine, resistance to all common cleaning solvents, ability to be laundered easily, and resistance to air and sunlight. The foams can be bonded to many materials, and the rigid foams can be used as core materials in metal structures.

Another use foreseen for urethane is in coated magnet wires which need not be stripped before soldering, thus speeding assembly operations. Expected to be marketed by the latter part of this year, the wire coatings have high moisture resistance, and withstand aging at temperatures of 130° C. and higher.

Mar-proof urethane paints which will soon be on the

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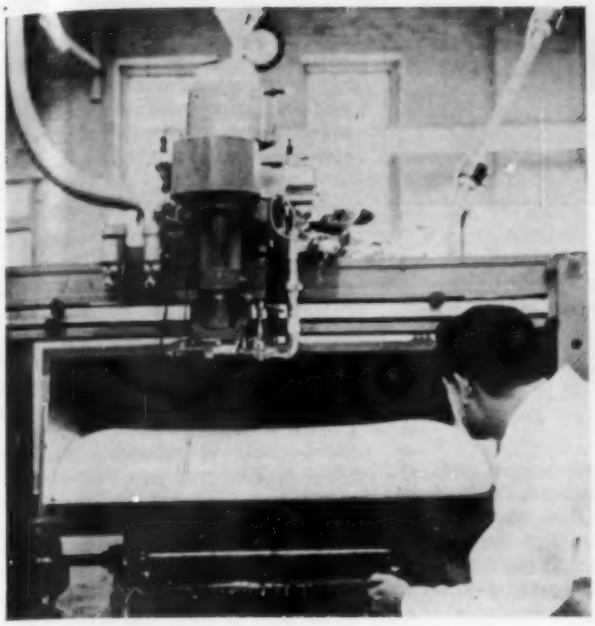

C—The production run completed;

D—Removing the wax-parted foam from the mold.

market provide a glass-like glossy surface on floors. These paints can be made in a wide range of colors, either transparent or opaque, and have high resistance to greases, oils, acids, and alkalies. —THE END

Vinyl Plastisol Bellows

A flexible expansion bellows has been made by Boonton Molding Co., Boonton, N. J., in a unique application of a vinyl plastisol material. As shown in the photograph, this bellows is used on the control unit of an antomatic pilot made by the Eclipse-Pioneer Division, Bendix Aviation Corp.

The plastisol material was selected for its superior oil resistance and low temperature flexibility. The unit is said to have withstood flexing tests of more than 7,000,000 cycles at room temperature with no visible effect, and flexes easily at temperatures as low as –65° F. The plastisols may be formulated with a wide range of physical characteristics to meet specific requirements. Primary properties are control of hardness and flexibility; resistance to mineral acids, alkalies, and petroleum products; excellent aging; and good fatigue and wear strength.

The molding technique used for the bellows is a development of Boonton's special products division, and is suitable for making products varying in thickness (see the inset of the bellows cross-section). A wide variety of sizes and shapes of products are claimed to be obtained with relatively inexpensive tooling which is suitable for short or long runs.

The bellows is used to keep dirt and foreign matter from entering a joint, and to keep excess lubrication from dripping out. Longer bellows can be used to cover hydraulic and pneumatic rams to protect the shaft packing and minimize leakage of fluids and lubricants.

—THE END

Vinyl plastisol bellows mounted on automatic pilot. Inset of bellows cross-section shows thickness variation.

News of the Societies

Automotive Engineers Hold Reinforced Plastics Symposium

The golden anniversary meeting of the Society of Automotive Engineers featured a symposium on "Fiber Glass Reinforced Plastic—An Automobile Body Material." The meeting was held in the Chalfonte-Haddon Hall Hotel, Atlantic City, N. J., on July 12-17, and the symposium included five papers on the material itself and three discussions of applications. Summaries of both sets of papers follow:

"Polyester Resins." Harold A. Hoppens, Barrett Division, Allied Chemical & Dye Corp. The term "polyester" usually refers to an unsaturated polyester resin base dissolved in a polymerizable monomer such as styrene. The resulting clear liquid is supplied in a wide range of viscosities, and is polymerized or cured just prior to actual use by the addition of a catalyst. A thermosetting material, polyesters have been developed for special applications requiring high heat distortion, fire and chemical resistance, and light stability. The most commonly used fillers, clay and calcium carbonate, are said to offer improved surface finish, lower shrinkage, and reduced costs. The use of fibrous glass reinforcing agents was not covered in this paper.

"Application of Reinforced Plastic for Major Body Panels." Carl Jakust, Chevrolet Motor Division, General Motors Corp. An important cost consideration in choosing between steel and reinforced plastics involves the number of parts to be made. According to the figures presented, a reduced volume would indicate plastic as the body material, whereas an increased volume would call for steel. Actually, reinforced plastics are finding their greatest applications in individual parts or low-volume assemblies where the additional piece cost is offset by the reduced tool cost, or where the physical properties of plastics are desired. An example is the Chevrolet special pickup truck which requires specially styled, complicated panels.

"Reinforced Plastic Heater Housings and Ducts." A. J. Carter, Chrysler Corp. The manufacture of a heater housing and duct system using sisal fiber reinforced polyester resin was discussed in detail. These two units as initially designed in steel required about 15 major stampings and over 100 minor parts. It was found that the plastic unit increased the hot air temperature by 10° F., owing to the elimination of leaks resulting from spot-weld sealing. Labor costs were reduced, and assembly problems created by poor fitting parts were eliminated. The plastic unit's appearance is good as it comes from the die, and requires no painting.

"Glass Fiber Reinforcement." C. E. Hoover and Ralph Sonneborn, Owens Corning Fiberglass Corp. Glass fibers as reinforcements for plastic offer greater mechanical strength than bulk glass. Chopped strands, rovings, non-woven reinforcing mats, milled fibers, yarns, surface and overlay mats, woven fabrics, and rove cloth are formed from a lime-alumina-borosilicate glass that is relatively soda-free. Commonly referred to as "E" glass, the fibers make possible great design latitude, as well as variations in strength, rigidity, cost, production methods, and directional characteristics. Individual filaments are available in several diameters from 0.0002-0.001 inch, and are said to possess a tensile strength of about 400,000 psi., regardless of diameter. Manufacture of the basic fiber and glass surface treatments were also discussed in detail.

"Design Factors to Be Considered." Woldemar Schultz, Ford Motor Co. The problem of how to design to take advantage of this new material (reinforced plastic) was discussed in terms of comparative ratings of material costs as against weight, curves of constant flexural and tensile strength, buckling, and compression. Integration (using diecasting shapes and primary bonding) allows strength where needed; permits weight saving; enhances strength through continuity of structure; reduces deflection under load through increased fixity of joints; and eliminates rivets, bolts, and sundry fasteners while also reducing dimensional coordination problems. Finally, in considering the passenger car body, a complete stress analysis of steel and plastic body deflections can and should be made for comparative purposes.

"Matched Die Molding Using Fiber Glass Preforms or Mat." Robert Morrison, Molded Fiber Glass Body Co. Deep matched metal dies have their own heating chambers where steam at pressures of 20 pounds or more provides the die heat. Accurately-machined matched metal dies are said to offer the only means for producing void-free fiberglass-reinforced plastic parts at low cost and in large volume. For immediate delivery and quantities of less than 300, other methods such as handlay-up, vacuum and pressure bag, and Marco methods should be used. To illustrate the matched metal method, Mr. Morrison traced the entire process of producing a 15-foot boat, a job which he described as directly applicable to the automotive industry. He also felt that mats, while slightly higher in cost, were more economical than preforms made from rovings. Preforms are necessary, however, when contours are difficult and maximum strength is needed.

"Matched Metal Die Molding of Premixed Reinforced Plastic Molding Compound." James Grieg, Woodall Industries. Premixed polyesters, fillers, and glass fibers can be blended in predetermined proportion and molded in matched metal dies. Premixes do not produce a product with the same physical properties as one molded from mat or preform, since the glass fibers do not have as uniform a distribution. A properly prepared premix with uniformly distributed fibers and adequate shelf life can offer numerous advantages in a number of applications. It eliminates the expense of making preforms or die-cut mat blanks; allows a greater variety of fibers and fillers to be used in their simplest form; reduces material waste; simplifies feeding of the die and removal of the part; and makes possible the molding of many details such as holes, bosses, slots, and grooves.

"Properties of Glass Fiber Reinforced Plastic." John G. Coffin, Chevrolet Motor Division, General Motors Corp. Available engineering data covering the mechanical and physical properties of reinforced plastics as a structural automotive material were reviewed. The discussion was limited primarily to molded panels containing approximately 40% glass, 15% filler, and 45% resin. Mechanical properties, with the exception of compressive strength, were found to increase in direct proportion to the glass content, and comparisons were based on 20-gage S.A.E 1010 steel as opposed to 0.100-inch thick plastic. Most of the reinforced plastic supplied to the automotive industry is about three times as thick as the steel it replaces, though only one-half the weight. Trebled thickness compensates for the greater strength of steel in terms of psi., and the crux of the plastic problem actually involves a compromise between stiffness and resilience. Eight charts comparing properties of steel and plastics were included, and it was pointed out that these new engineering materials have a permanent, ever-broadening place in the automotive industry.

Rutgers University Slates Quality Control Course

The University Extension Division of Rutgers University, New Brunswick, N. J., has scheduled its Sixth Basic Conference Series on Statistical Quality Control for nine Wednesday afternoons and evenings from October 5 to December 7, inclusive. The emphasis will be on the applications of modern quality control to industrial processes and special emphasis on management's problems.

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The University is also offering evening courses in Applied Statistics and Quality Control for engineers, chemists, physicists, and biologists who are engaged in production or development work. These courses are geared to the personal needs of technical men who may not have responsibility for developing a quality control program within their companies.

Further information and applications for the Series should be addressed to Dr. Ellis R. Ott, Rutgers University, 77 Hamilton St., New Brunswick, N. J.

Malone Discusses Rigid PVC

The May 25 meeting of SPE's Toledo Section was held at the new Toledo Express Airport with approximately 35 members and guests being present for dinner in the Airport dining room. The Section then toured the Airport control tower and was shown the various navigational devices and facilities in operation.

Jean F. Malone of B. F. Goodrich Chemical Company, discussed "Rigid Polyvinyl Chloride and Its Applications," tracing the history of rigid polyvinyl chloride from its commercial introduction in this country about 1950, through a usage of about 250,000 lbs. in 1952 and 2,500,000 lbs. in 1954, to an estimated 25,000,000 lbs. in 1955. This impressive performance has resulted from a combination of outstanding chemical resistance, good physical and thermal properties, and satisfactory processing characteristics. Rigid PVC is presently used as a structural material in the piping, building material and lighting fixture industries.

The ultimate possibilities in the pipe field were stated to be of enormous potential, perhaps approaching the total present polyvinyl chloride market in size. The types of piping applications suitable for polyvinyl chloride were described as pipes, valves and fittings for the chemical, food and paper industries, oil country line pipe for sour crude oil and brine disposal lines, irrigation lines (no scaling or fouling of nozzles), general services (water, etc.), and electrical conduit. The satisfactory chemical resistance demonstrated in tests run for 30 days at 140° F. against sulfuric acid, nitric acid, sodium hydroxide and other typical reagents was noted, and reference was made to the extensive German experience in rigid PVC chemical plant piping and equipment. Engineering performance data relating to long time safe working stresses at 80° F. and 100° F. were presented to assist the designer in utilizing both Type I and Type II rigid PVC for structural uses.

The use of rigid polyvinyl chloride for corrugated sheeting, opaque wall panelling and lighting fixtures in the building industry was described. Rigid PVC corrugated sheeting is not recommended for external use because of ultra-violet color degradation. It should be noted, however, that one year Florida weathering tests on pipe failed to bring about any significant decrease in strength.

Reinforced Plastics Tooling

The Reinforced Plastics Group of SPE's New York Section held its regular dinner meeting on May 25 at Tufaro's Restaurant, Corona, with 57 members and guests attending. Robert J. Brinkema, Brinkema Plastics, served as moderator of a five-man panel on "Tool Design in Molding Reinforced Plastics."

John C. Moricoli, C. L. Gougler Machine Co., opened the panel talks with a discussion of "Machining of Matched Metal Molds for Molding of Reinforced Polyester Resins." He outlined six basic steps imperative for high quality mold making: pre-design planning, mold design (lay-out), approval of mold design by the molder, purchasing of mold steels, detailing of mold design, and pre-machining conference between engineering and production. Mr. Moricoli also made recommendations concerning steels, hardening of molds, chrome plating, finishes, tolerances, shear edges, and standardization of inquiries.

"Cast Aluminum Tooling" was the subject of a talk by John Avignone, M. A. Cuming & Co. Differential expansion in steel and aluminum limits molds designed from the latter material to the resin seal type, straight compression, or a landed mold. Heating and cooling advantages of cast-in tubing can be utilized in aluminum castings due to the metal's high conductivity. Molds should have uniform wall thickness with additional strength possible through rib constructions and annealing. Ease of machining and lightness of weight are reported economy features.

The Kellering process was outlined by Milton Hoffman, Victor Kellering, Inc. Victor Kellering machines are used as automatic tracers for controlled molding, and work on an electrical principle. Close tolerances of (five mils) on material thickness are possible; however, speed is difficult to obtain. The process is used essentially to obtain accurate matched metal molds, and is not intended to compete with the two aforementioned methods.

"Design of Matched Metal Molds from the Molder's Viewpoint" was presented by Sidney D. Yarm, Bassons Industries Corp. He listed the following considerations as essential to mold design: quantity of parts required, part size, complexity of part, surface finish desired, whether trimming and blanking are to be performed in the molding operation, likelihood of design changes, and the type of delivery schedule involved. Advantages of aluminum, cast iron, Meehanite, and steel molds were considered. A major difficulty encountered by the molder in working the molds is the securing of proper draft; one degree minimum being required.

Frank Nussbaum, Riverside Plastic Corp., described bronze molds as releasing well without inhibiting the cure. Expensive, they best serve in molding situations requiring intricate shapes and indefinite wear. After polishing, chrome plating and buffing serve well for parts requiring painting; porosity is limited by impregnating the mold with a parting agent having a non-aqueous base; and molds are best cleaned with paper which is immediately thrown away.

Parks Addresses Miami Valley

Thirty-seven members and guests attended the final meeting of the season of SPE's Miami Valley Section, held on May 5 at Schuylers Restaurant, Cincinnati, O. Lloyd E. Parks, Logo, Inc., addressed the group on "Coating of Plastics."

Any pigmented coating for plastic parts consists of both resin and solvent systems, Dr. Parks said. The former must possess pigment-carrying ability, flow, and adhesion to the plastic being coated. Solvents must not attack the part itself, nor cause crazing, etching, cratering, or humidity blush.

Methods of application must be considered in the formulation of a solvent system. A blend of high and low boiling solvents is used for spray coatings to prevent solvent loss during application. This would increase the solids content and the viscosity of the wet film. Dr. Parks also pointed out that adhesion failure could usually be traced to humidity blush, mold lubricants, internal lubrication of the plastic material, or the presence of oil or water in the air line of the spray apparatus.

Elastomer and Plastics Group Holds Short-Talk Symposium

The Annual Short-Talks Symposium of the Elastomer and Plastics Group, Northeastern Section, American Chemical Society, was held at the Massachusetts Institute of Technology, Cambridge, Mass., May 17, with William H. Crandall, Frederick S. Bacon Laboratories, presiding. Fifty-five members and guests attended.

The five speakers and their subjects included Ernst A. Hauser, MIT, "The Morphology of Elastic Silicones"; Kenneth A. Loftman, Godfrey L. Cabot, Inc., "General Characteristics of Synthetic Silicas"; Irving Pockel, Cambridge Industries, Inc., "Special Polyesters"; Martin E. Conroy, M. W. Kellogg Co., "Kel-F Elastomers"; and Richard S. Cass, Frederick S. Bacon Laboratories, "The Determination of Plasticizer Vapor Pressure."

Mr. Pockel discussed the common monomers and their polymers in terms of plasticizer needs, and dealt with the dibasic acids and glycols now commercially available as sources of material for completely polymerized, liquid plasticizers. He described the investigation that led to the discovery of adipic acid-diethylene glycol as the only satisfactory plasticizer of this type for polyvinyl acetate, and concluded with an outline of the plasticizers suitable for polyvinyl chloride and polyvinyl alcohol.

Mr. Cass discussed the three methods for vapor pressure determination, namely, the static method, the boiling-point method, and the gas saturation method. He described the equipment he had devised to measure vapor pressure by gas saturation. This technique consists of passing a dry stream of nitrogen at constant rate and temperature through a 30 cc. sample of plasticizer contained in a glass bead-filled scrubber, from there into a heater, and finally through a weighing trap in a dry ice-cooled Dewar flask.

NEWS of the INDUSTRY

Carlisle Acquires Advance

Carlisle Chemical Works, Inc., Reading, O., has announced the acquisition of Advance Solvents & Chemical Corp., New York, N. Y., together with its subsidiary companies. The merger is expected to be mutually advantageous, in that Carlisle will be able to expand its operations in the field of chemical additives, and Advance will have access to additional manufacturing and research facilities. No change in corporate name is anticipated.

Advance manufactures driers for the paint and printing industries, plasticizers and stabilizers for the plastics and rubber industries, and numerous specialty compounds. Plant facilities are located in Jersey City, N. J., and subsidiaries include Advance Solvents & Chemical Corp. of Canada, Ltd., and Advance International, Ltd.

FEMCO Doubling Facilities

A plant expansion program that will double the production, engineering and office area of The Falls Engineering & Machine Co., Cuyahoga Falls, O., is currently underway, the company reveals. For the purpose, 80 feet of frontage adjoining the present facilities has been purchased, and already contains a brick building housing the engineering offices of Campbell Machinery Development Co., which designs special rubber and plastic machinery built by Femco.

A new addition will consist of the shipping and receiving departments, a paint and carpentry shop, and material storage. Other space will be converted into additional assembly area for heavy machinery and for shop and office space.

Foxboro Regional Divisions

Ten regional sales divisons have been established by Foxboro Co., Foxboro, Mass., as part of a program of intensifying its instrument sales engineering coverage. The new regional structure will be administered by H. O. Ehrisman, newly-appointed general sales manager, and J. J. Burnett, field sales manager. The firm has 48 branch offices across the country.

The 10 regional sales offices and their managers include New England, H. H. Michelmore; New York, E. R. Huckman; Philadelphia, J. B. Deaderick; Pittsburgh, A. H. Shafer; Atlanta, E. W. Prendergast; Cleveland, H. L. Lee; Chicago, J. J. Connelly; Dallas, E. L. Stark; Houston, L. W. Parten; and San Francisco, R. E. Rogers.

Erecting Research Facility

A $3,000,000 engineering and research building devoted to the development of new products in the fields of aerophysics and electronics is being constructed by Goodyear Aircraft Corp., Akron, O., it was revealed by P. W. Litchfield, president of the firm and chairman of the board of The Goodyear Tire & Rubber Co.

The new three-story steel-and-concrete air-conditioned building will have dimensions of 400 by 125 feet and will adjoin the north end of the firm's Plant C. Work is expected to be completed by the summer of 1956. Modernization and improvement of other Goodyear aircraft facilities is scheduled to begin within the next few months.

In making the announcement, Mr. Litchfield declared, "Our new building will permit the efficient concentration of our engineering and research personnel and provide for expansion of our technical staff to meet the rising tempo of scientific engineering and research requirements under modern working conditions."

Goodyear established its first aeronautics department in 1910. The company currently makes non-rigid airships, guided missiles, analog computers, radar devices, plastic radomes and canopies, and other aircraft and related products.

New F-B Test Machine

Farrel-Birmingham Co., Inc., Ansonia, Conn., has installed a new 300,000-pound maximum load bearing testing machine in its laboratory for the full-scale testing of large plain bearings under simulated operating conditions. Tests will be conducted on bearings commonly used in company products, such as Banbury mixers, and rubber and plastics mills and calenders, to determine effect of speed, surface finish, journal temperature, and oil viscosity.

The machine has a basic journal size of 14-inch diameter, and receives its power through a hydraulically actuated lever system with actual force measured by strain gage. The main framework is constructed as a circular ring so that the frame can be rotated to apply load from any direction. The driving means for the rotating journal includes a torque meter for measurement of friction torque. Thermocouples are placed in bearing liners to record the bearing temperature during tests. The test journal can be heated to mill and calender temperatures.

Petroleum Chemicals to Boom

Petroleum chemicals are no longer considered by-products, but are now one of the main objectives of modern petroleum processing, Carl O. Tongberg, a vice president of Esso Research & Engineering Co., New York, N. Y., told the midyear meeting of the Interstate Oil Compact Commission at Denver, Colo.

Dr. Tongberg particularly cited the rise of the petroleum-derived plastics and synthetic rubber industries as evidence for his assertion. National petrochemical production, he said, today totals about 30 billion pounds annually compared with 150,000 pounds recorded for 1920, with all indications pointing to continuing growth.

Resins and plastics made from petroleum, he continued, are replacing steel in automobile parts and pipes, lumber in building panels and boat hulls, rubber in wire insulation and gaskets, ceramics in dinnerware, paper in transformer coils and packaging materials, and leather in footwear and upholstery.

Opens Tokyo Sales Office

A new Far Eastern sales office has been opened in Tokyo, Japan, by Dow Chemical International, Ltd. Occupying quarters in the Sanshin Building, the branch will service Japan, Hong Kong, the Philippines, India, Formosa, Australia, and New Zealand.

Sales and product information, technical service, samples, and literature on a wide variety of products, including Styron, will be available through the new office. H. Lee Clack has been appointed manager and Howard C. Visger, assistant manager of the branch. Continuing as Far Eastern sales manager, Eric C. Huggins will also be associated with the new office.

Plastic Decorators Merge

Art Roll Leaf Stamping Co., and Art Marking Specialists, Inc., associated companies located at 4201 Hudson Blvd., North Bergen, N. J., have merged. All future dealings with the two companies should be addressed to Art Decorating Co., at the same address. There is no major change in company management.

Art Roll Leaf decorated plastics and other materials by hot stamping, and Art Marking performed the same type of service by the silk screen and offset printing processes.

Predicts Increased Demand for Polyethylene-Paper Packings

Polyethylene output in the range of 627 million pounds per year, tripling present production, was predicted by H. K. Intemann, vice president and general sales manager of Bakelite Co., New York, N. Y., in a speech before the Specialty Paper and Paperboard Affiliates in Chicago, Ill., on May 25. "A one-mil coating on only one

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side of a milk carton would consume about 54-million pounds of polyethylene per year based on present carton production," Mr. Intemann predicted, "and this is only one phase of the potential market envisioned for paper-plastic combinations.

"Disposable hospital sheets made of paper backed with a film of polyethylene in much the same way could ultimately consume 9½-million reams of this coated paper per year. One clean sheet per day on each of the 1½-million hospital beds in the U. S. would consume about 75-million pounds of polyethylene in a year, even with 0.0005-inch thick coating." Mr. Intemann also spoke of disposable coated diapers, cereal boxes, chewing gum packages, and roofing papers.

Uses Nylon Measuring Cup

A molded Zytel nylon cup for measuring soil properties is being used by Industrial Devices, Inc., in conjunction with its portable conductivity bridge. Low electrical conductivity, toughness, resistance to corrosion, and freedom from cold flow under conditions of high temperature and humidity reportedly make DuPont's Zytel Type 31 ideal for this particular application.

Determination of the total soluble salt or fertilizer content of soils by measuring the electrical conductivity of a moistened sample or a water extract has proved to be a rapid and accurate method of testing. The design of the soil cup has been recommended by the U. S. Department of Agriculture.

Flashlight Employs Phenolics

A uniquely designed plastic reflector assembly, featuring automatic circuit cut-off to prevent fire or explosion, is incorporated into the new line of Eveready safety flashlights. A wire bulb guard running through two slots in the phenolic reflector is attached to the spring-loaded phenolic retainer, which opens the circuit instantly when the bulb is broken. This prevents the exposed filament from igniting inflammable or explosive mixtures of gas which might be present.

Mounts and guides for the spring-loading assembly, exterior threads, and slots for the wire guide are all produced in one molding operation by the Auburn Button Works, Inc., Auburn, N. Y., using a nine-cavity compression mold. The bulb seat height is held to close tolerances, providing a uniform parabolic reflector. The reflector face is vaporized with aluminum for maximum reflectivity and sprayed with a protective coating of clear lacquer.

The phenolic retainer is produced in a 12-cavity high speed plunger mold, maintaining a close fit between the outside diameter and the inside diameter of the reflector. The assembly has been approved by the United States Bureau of Mines for use in methane-and-air mixtures, and carries UL approval for Class I and Groups C and D service.

Offers Two-Fold Service

The finishing of plastic parts has become a regular feature on the agenda of the Queens Workshop, a non-profit rehabilitation service for patients recovering from tuberculosis and heart disease. Sponsored and subsidized by the Queensboro Tuberculosis and Health Association, Inc., Jamaica, N. Y., the shop enables ambulatory patients to work part-time under medical supervision. In this way the patient's stamina and job skills are built up gradually until he can assume full-time employment.

Workshop employees do piece-work such as hand-stamping, molding, hand-finishing, and packaging to fill sub-contracts for Queens manufacturers. This work is contracted for throughout the New York City metropolitan area on a competitive basis, and job orders have included plastic screw anchors, tiles, brushes, plastic straws, parakeet toys, and electronic equipment. In this manner, the high cost of job training, which is often a deterrent to hiring former patients, is obviated by the prospective employer.

New Goodrich Building

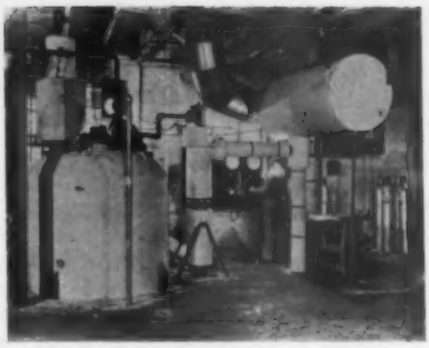
Construction of a three-story commercial office building intended for the sole occupancy of B. F. Goodrich Chemical Co. is now under way at 3135 Euclid Ave., Cleveland, O., it has been disclosed by John R. Hoover, president. The building will be erected and leased to Goodrich by Mintz Construction Co., Cleveland.

To have a gross area of 52,000 square feet, the structure will show an aluminum-and-glass facade and will have a steel frame construction designed to permit the possible addition of other areas. Occupancy is scheduled for May 1956.

Utilizes Alkyd Components

Plaskon Alkyd 446 is being utilized in components of oil well drilling instruments, according to company spokesmen at Keystone Engineering Co., Houston, Tex., because it offers dimensional stability, strength, good electrical properties, and freedom from "wicking" at temperatures up to 300° F. A product of the Barrett Division, Allied Chemical & Dye Corp., New York, N. Y., the material is also being molded for subsurface exploration devices.

Actual parts made include connector plugs for electrical logging devices, brush holders for gun perforators, pulsator mandrels, and various insulator bushings. In these applications the alkyd is enclosed, and does not come in contact with the mud and superheated water in the drilling fluids for prolonged periods.



Portion of Thiokol's expanded facilities for producing plasticizers.

Expands Plasticizer Production

Increased demand for low temperature plasticizers has caused Thiokol Corp., Trenton, N. J., to double its capacity for producing plasticizers TP-90B and TP-95. Used with both vinyl resins and rubbers, these plasticizers maintain high resilience over a wide temperature range, are compatible with elastomers, and retain their physical properties at high concentrations.

Lower volatility and better dielectric properties are expected to result from the new equipment and processing refinements. Stainless steel equipment is used to minimize color.

Resdel Engineering Expands

A 21,000-square foot brick building, ten times the original plant size, will house the expanded facilities of Resdel Engineering Corp., manufacturers of Electronheat dielectric heaters for the plastics industry. Engineering and research departments, as well as production, will be located at 330 South Fair Oaks Ave., Pasadena, Calif.

Resdel has effected a number of changes in circuit design in an effort to extend the range of materials which can be heated dielectrically. Several models have been devised for the continuous production of extruded fiber glass shapes. The company also produces Doppler radar systems.

Reports Plastics Demand

A record-breaking demand for switches, switchboards, circuit breakers, and other electrical parts incorporating plastics was reported by F. W. Magin, president of the Square D Co., Detroit, Mich., at an annual meeting of the company's Molded Insulation division in Peru, Ind. He also disclosed an increased demand for industrial control products used in automation installations.

Square D's Peru plant is a major producer of plastic and porcelain insulation and structural components for electrical equipment. The company also maintains eight other plants throughout the U. S., Mexico, and Canada, and plans two additional facilities at Secaucus, N. J., and Cedar Rapids, Ia.

New Plastic Diffusers with Improved Light Stability

Accelerated aging tests conducted by Sheffield Plastics, Inc., Sheffield, Mass., on its extruded plastic diffusers for fluorescent fixtures have indicated a light stability which will resist discoloration for seven years of normal use. This is reportedly equivalent to the best performance of top quality polystyrene diffusers now available.

With the use of a test employing mercury arc lights, Sheffield is able to eliminate batches of raw material which exhibit excessive discoloration. It was also found that relatively small amounts of ultra-violet light were transmitted through the glass envelopes of fluorescent lights. These, in turn, attacked certain chemical elements present in the plastic material in amounts which vary from batch to batch. Quality control eliminated much of this problem.

The test itself involved setting up a 500-watt mercury arc lamp with a quartz envelope which transmitted light over the entire wave band or spectrum desired. A filter, which removes all light rays except those emitted by a fluorescent light, is inserted between the light source and the plastic sample, and the material is exposed for 48 hours. Sample extrusions of the control material are kept in absolute darkness to insure accuracy.

H-P-M Announces Future Plans

Two management decisions bearing on future operations of The Hydraulic Press Mfg. Co., Mount Gilead, O., were announced by G. B. Robinson, chairman of the board. Despite reports of consolidation negotiations, H-P-M will continue as an independent company. To that end, key personnel have been named to carry out the decisions reached by the board in its policy review.

William H. Bennett was appointed vice president in charge of sales. He previously served as director of engineering for the firm, and more recently as sales manager of Lake Erie Engineering Corp. J. W. Arnold becomes vice president in charge of manufacturing, having formerly served as general manager of Erie Engine & Mfg. Co. William N. Woodward has been named secretary-treasurer. He has been with the firm since 1950 as controller and assistant secretary. Robert J. Lindsey, former chief engineer of Elmes Engineering Division, American Steel Foundries, has been appointed director of engineering. Glen R. Pittman was named sales manager of the hydraulic power division.

Du Pont to Market New Alathon

Low pressure Alathon polyethylene should be available in pilot-plant quantities by early fall, according to spokesmen of E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. The material, which is licensed to Du Pont under Zeigler patents, will be produced at the new pilot plant now under construction at the company's Sabine River Works near Orange, Texas.

In commenting on the forthcoming addition to the 19 types of Alathon presently marketed, it was pointed out that the new material actually consists of a group of widely differing materials rather than a single resin. Modified polyethylene should greatly extend the range of properties for resins now produced commercially.

Previous modifications have produced tough, pliable films for packaging operations; high density materials for plastic piping; and polyethylenes with improved heat resistance for use in the electrical industry. Du Pont expects many more formulations which will greatly expand polyethylene's usefulness.

In Brief . . .

Carbide & Carbon Chemicals Co., New York, N. Y., has announced the availability of Carbowax polyethylene glycol 20M in pellet form. White in color and having a maximum diameter of ½-inch, the pellets dissolve readily in water in concentrations up to 50% by weight.

The Alfred P. Sloan Foundation, Inc., New York, N. Y., has set up a fund of $5 million for the promotion of basic research in the physical sciences. A special gift to the fund by Mr. and Mrs. Alfred P. Sloan, Jr., will be provided for this specific purpose.

Argus Chemical Corp., Brooklyn, N. Y., has announced a price reduction of 4¢ per pound of their low temperature epoxy plasticizer Drapex 3.2. The present price is established at 40¢ per pound in bulk, freight allowed and prepaid.

The Chemical Market Research Association, New York, N. Y., at its annual business meeting on May 18, elected the following officers for the fiscal year beginning July 1: president, C. P. Neidig, White Weld Co.; president-elect, E. M. Ott, Pennsylvania Salt Mfg. Co.; treasurer, F. S. Godron, Victor Chemical Co.; secretary, W. D. Morrison, Celanese Corp. of America; and five directors: W. H. Healey, General Aniline & Film Corp.; Parker Friselle, Dow Chemical Co.; D. L. Taylor, Hooker Electrochemical Co.; L. H. Flett, consultant; and S. D. Koonce, Jefferson Chemical Co., Inc.

E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., has announced a reduction in the price of Zytel nylon resin molding powders of approximately 15¢ per pound. In addition, the material will be stocked in regional warehouses to expedite shipments.

Tee-Pak, Inc., Chicago, Ill., has introduced what is reported to be the first metallic colored, plastic food casing. The new casings are available in either Saran roll stock or Saran tubes.

Diamond Alkali Co., Cleveland, O., has announced the acceptance by Underwriters' Laboratories, Inc., of their Diamond PVC-50 as an interchangeable basic resin for use in all UL-listed vinyl electrical compounds. New insulating compounds for T and TW building wire and 80° C. appliance wire have also been accepted by UL, the manufacturer reports.

Tri-Point Mfg. & Developing Co., Inc., Brooklyn, N. Y., have announced the production of extruded electrical grade Teflon rod in diameters from ¼-2 inches. Tri-Point offers a custom machining service for precision Teflon and other plastic electronic, chemical, aircraft, and industrial components.

E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., has announced a price reduction of 35¢ per pound on all types and gages of Mylar polyester film except 25-gage, the thinnest film. Present prices range from $2.50 per pound for the heavier films to $4.00 for 25-gage.

Minnesota Mining & Mfg. Co., St. Paul, Minn., demonstrated transmission of color television on magnetic video recording tape during the dedication of their new research center. The program originated in New York City and was sent through a closed circuit to Minneapolis' Foshay Tower from which it was micro-waved to the auditorium of the central research laboratory. The tape, developed by Minnesota Mining, records both the audio and video portions of the original television signal, and reproduces them immediately on the playback.

Plexolite Corp., El Segundo, Calif., has announced a change of corporate name to Filon Plastics Corporation. Filon manufactures translucent, shatterproof materials for the reinforced plastics industry.

Quaker Oats Co.'s chemicals department, Chicago, Ill., and the petrochemical department of Standard Oil Co. of Ohio have joined the Manufacturing Chemists' Association. MCA represents over 90% of the chemical industry's productive capacity.

(Continued on page 392)

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News from Abroad

Plastics in Austria

Austria's consumption of plastics in 1954 showed an increase of at least 25% over that of 1953, trade estimates indicate. It is calculated that the 1954 total reached 10,000 tons against not quite 8,000 tons the year before. PVC made the most progress, and its upward trend of consumption is continuing to the extent that it is reportedly planned to triple output before long. In 1954, local manufacturers took 2,900 tons of the plastic, part of which had to be imported. Incidentally, PVC production here seems to have been made possible by aid under the Marshall Plan.

About 1,400 tons of phenolic urea, and melamine compounds, of which 85% was produced locally, were used by converters, besides unspecified amounts by the cable industry, producers of wood fiber panels, and other industries. While Austria has been manufacturing phenolic and urea compounds for some time now, all the melamine has had to be imported through 1954, but production of this plastic, too, is to be started this year.

Among the other plastics consumed in 1954 were 340 tons of polystyrene, 45 tons of polyethylene (both imported), about 500 tons of the older type of plastics (celluloid, etc.), and very small amounts of polyester resins, polyamides, and the newer plastics. Polyvinyl acetate emulsions and copolymers are to be produced this year by Vereinigte Chemische Fabriken, Kreidl, Rutter & Co.; and polyester resins by Vianova Kunstharz A. G., in collaboration with Reichhold Chemie A. G. To begin with, 5-10 tons of polyester resin will be produced monthly, but the existing plant has a capacity of 50 tons monthly so that output can be considerably stepped up when necessary. Another Austrian firm is considering the manufacture of glass fiber for reinforcing the resins.

It appears that the reinforced plastics are expected to take the place of steel plate for various purposes because their use would permit the economical manufacture of limited quantities of products, whereas the use of steel plate is only profitable for large volumes requiring expensive equipment.

Pressure-molding of Glass-reinforced Plastics

In molding contoured plastic parts in a mechanical press, obtaining even, perpendicular pressure at all points is a problem because of the slanting sides of the mold. In the case of glass-reinforced plastics, there is also the danger of breaking the glass fibers if mechanical force is too great. Technique du Verre Tisse, Paris, France, recently patented a method in which the piece to be shaped is pressed against the rigid walls of a mold by the action of an enveloping flexible, air-tight bag which is subjected to both internal and external pressure, the latter pressure being greater than the former. The bag containing the piece and its mold is introduced into an autoclave in which the desired amount of excess pressure can be maintained. Atmospheric pressure is brought to the inside of the bag by means of a tube through an appropriate neck in the wall of the autoclave. This bag, which may be of rubber, rubberized fabric, or other flexible air-tight material, has small cylindrical studs molded on its interior face. These studs are evenly spaced and of such dimensions that, when they are flattened in the molding process, evacuation channels are formed by which the exudate can pass to the orifice in the bag leading to the free air. Between the studs and the part to be molded is inserted a cellulose acetate rayon fabric which prevents excessive marking of the product and facilitates unmolding. The fabric should be absorbent, and is usually discarded after being stripped from the molded part.

New Head on Trudex Extruders

An extruder head has recently been patented in France which is designed to prevent the decrease in pressure that develops in the course of the extrusion of thermoplastics, and the consequent lack of uniformity and distortion of extrusions. The device, which Trudex S.A., Paris, has embodied in recent extruders and which, with a few slight changes, can also be used for injection, includes a nozzle channel with feed and delivery orifices, a die with a spherical end followed by a constriction on the feed side, and an annular bulge (with its constrictions) in front of the delivery end of the head.

The die is provided with fins integral with a ring fitted into the head. The fins have a plane face in a radial plane, and another plane face inclined with respect to the radial plane. The successive constrictions in this extrusion head cause the material to pass through a series of throttling and expansion zones, with the section calculated so as to provide maximum pressure in the immediate vicinity of the extrusion orifice. The asymmetrical orientation of the plane faces of the fins insures perfect compression of the material after its passage around the fins.

This device is said to have given unusual results in the manufacture of tubes and rods of unplasticized PVC.

Plastics Industry in France

French production of plastics in 1954 was approximately 70,000 tons, almost nine times as high as it was in 1938 when production was estimated at 8,000 tons, according to M. Mottu, president of the Union des Syndicats de la Transformation des Matieres Plastiques. As compared with the 1953 figure of 45,000 tons, there has been an increase in production of 63%, while consumption was 47% higher.

The following tabulation gives the approximate amounts of the various plastic materials made in 1954:

	(metric tons)
Cellulose products	5,000
Polyvinyl chloride	24,000
Polyvinyl acetate	3,000
Polyamides	800
Polyethylene	1,800
Polystyrenes	8,000
Methacrylate	830
Phenoplastics	8,850
Aminoplastics	8,400
Solutions	3,350
Soluble resins	7,800
Silicones	150
Various compounds	1,950
Polyesters	70

France is now also exporting plastic materials, chiefly to the French overseas countries, Germany, Northern Europe, Belgium, Luxemburg, and Latin Europe.

The number of French plastics fabricators is growing steadily and now includes 802 injection molders, 498 compression molders, 11 producers of laminates, 403 high frequency welders, 220 firms engaged in vacuum molding, 134 extruders, 137 machining and laminating installations, 26 calenderers, and 50 miscellaneous. In addition, there are about 1,000 small workshops, making well over 3,000 establishments in all. However, since this total includes companies which are engaged in several types of fabricating work and thus are listed more than once, the actual number of firms is rather less than 3,000.

Epoxy Stabilizer for PVC

A French firm has developed an epoxy stabilizer chiefly for PVC-based compounds. The material is a liquid which is basically non-toxic, but which still requires precautions to prevent inhalation. Used in proportions of 1.5-2% on the vinyl resin, with which it is entirely compatible, the epoxy serves chiefly as a heat stabilizer, but is also a good light stabilizer and is often used as such. When used in combination with metallic stabilizers (particularly cadmium or barium-cadmium), a synergetic action develops, when heat stabilization is completed, which serves to improve considerably the light stabilization. The epoxy gives excellent results in all the usual mixes and, when used either alone or with 0.5% of cadmium stearate, can replace stabilizers based on tin salts in flexible, transparent mixes.

NAMES in the NEWS

T. M. Wennergren

T. M. Wennergren succeeds **H. W. Cyphers, Jr.,** as advertising manager of the plastics and resins division, American Cyanamid Co., New York, N. Y. He has served as assistant advertising manager since 1948.

William F. Kelly has been appointed to the newly created position of sales correspondent for the kinetic division, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., working out of the New York district office.

W. C. Walker has been named assistant to the vice president in charge of advertising and public relations of Witco Chemical Co., New York, N. Y.

Duncan K. Law has been appointed sales representative for Stanley Chemical Co., East Berlin, Conn., covering northern New Jersey.

Howard R. Medici

Howard R. Medici was elected president of Visking Corp., Terre Haute, Ind., succeeding the late **J. Paul Smith.** He joined Visking in 1929 as sales manager, and has served as secretary and executive vice president. **Leslie E. Houck**, vice president and general manager of Visking, Ltd., a wholly owned Canadian subsidiary, has been elected to the board of directors. Pending stockholders' approval of its move to increase the board's membership by one, the directors also named **E. B. Cahn,** general manager of the company's plastics division, to fill this newly created vacancy.

John F. Whitcomb has been advanced to general sales manager of the coated abrasives and related products division of Minnesota Mining & Mfg. Co., St. Paul, Minn., and **Richard L. Sheppard** has been promoted to general sales manager of the cellophane tape division.

J. R. Durland and **R. S. Wobus** have been appointed technical production managers for Monsanto Chemical Co.'s organic chemicals division, St. Louis, Mo. They previously served as plant managers for the John F. Queeny plant in St. Louis and the William G. Krummrich plant in Monsanto, Ill., respectively. **Howard L. Minckler,** former manager of the Avon, Calif., plant replaces **Mr. Durland,** and **Mr. Wobus** is succeeded by **Joseph Cresce** who managed the plant in Nitro, W. Va. The Avon job goes to **Dominic Danna,** and **Robert E. Soden** takes over at Nitro.

John D. Serpico

John D. Serpico has been named assistant technical service manager for Marbon Corp., Gary, Ind. He has served as chemist, plant manager, and development manager for various plastics and rubber firms.

Harold L. Jungman has been advanced to Eastern district sales manager of National Lead Co.'s Titanium Pigment Corp., New York, N. Y.

Latane De S. Lamb has been named technical sales representative for Atlas Powder Co., in the Houston, Tex., area. He succeeds the late **Allen V. Riley**, who died on June 10 following an extended illness.

Robert J. Musser has been appointed assistant manager of the market research department of Carbide & Carbon Chemicals Co., division of Union Carbide & Carbon Corp., New York, N. Y.

Gerald A. Ward

Gerald A. Ward has been appointed distribution manager for Bakelite Co., New York, N. Y. Former superintendent of services at the Bound Brook plant, **Mr. Ward** will direct plastics packaging methods, order entry, distribution, warehousing, and inventories.

Richard A. Briggs has been promoted to head of polymerization research on olefinic materials for The General Tire & Rubber Co., Akron, O.

William H. Schuette, recently appointed assistant to the general manager of Dow Chemical Co.'s Midland division, Midland, Mich., becomes general manager, freeing **Mark E. Putnam** for company-wide administrative affairs. In his new capacity, Dr. Schuette will assume administrative direction of the division.

William H. Bowman has been appointed assistant general manager of the organic chemicals division, American Cyanamid Co., New York, N. Y. He formerly served as vice president of Jefferson Chemical Co., Inc., a jointly-owned subsidiary of American Cyanamid and The Texas Co.

Jean Raeburn, N. Y.

Richard W. KixMiller

Richard W. KixMiller was elected vice president in charge of the chemical division, Celanese Corp. of America, New York, N. Y. He has served as general manager of the division for the past three years.

William H. Bowman has been appointed assistant general manager of the organic chemicals division, American Cyanamid Co., New York, N. Y.

Philip M. Dinkins has been elected vice president of operations for the dyestuff and chemical division of General Aniline & Film Corp., New York, N. Y.

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J. William Robinson has been named manager for the new Toronto, Canada, sales office of F. J. Stokes Machine Co., Philadelphia, Pa. He formerly managed the Montreal, Ont., office. **Fred Walters** joins the Toronto sales staff, which is located at 27 Wellington East. **Roger H. Watkins** joins the Cleveland, O., sales staff as senior sales engineer. **Paul Bixler** and **James Culton** have been appointed to the headquarters staff of Stokes' international division, with offices in Philadelphia.

H. C. Milton has been appointed department manager; **R. L. Lambert,** assistant manager; and **J. F. Allen,** Eastern sales manager for the manufacturers chemicals department of American Cyanamid Co.'s industrial chemicals division, New York, N. Y.

Willard Stewart, Inc.

Carl W. Eurenius

Carl W. Eurenius, director of sales for Hercules Powder Co.'s cellulose products department, Wilmington, Del., has been appointed assistant general manager of the department. **Werner C. Brown,** assistant director of sales, succeeds Mr. Eurenius.

Max A. Minnig, executive vice president and director of sales of Witco Chemical Co., New York, N. Y., and **John A. White**, export manager of Witco Chemical Co., Ltd., London, England, have been elected to the board of directors of Witco Chemical Co., Ltd.

A. R. Tucker, Jr., Styrofoam sales manager since 1952, and **Robert L. Curtis,** supervisor of plastics sales in the Southern California area for Dow Chemical Co., Midland, Mich., have exchanged assignments.

C. C. March has been named general manager of the coated abrasives and related products division of Minnesota Mining & Mfg. Co., St. Paul, Minn., and **R. W. Mueller** has been named general manager of the fibrous and industrial tape division. Three vice presidents of the company who have been given expanded responsibilities are: **Clarence B. Sampair,** now in charge of the tape and ribbon products group; **Joseph C. Duke,** who assumes charge of the adhesives and coating division; and **Hubert J. Tierney,** who will head the newly-formed plastic division and has been named chairman of the tape planning committee.

Walter J. A. Connor

Walter J. A. Connor has been elected executive vice president and a director of American Plastics Corp., a wholly owned subsidiary of Heyden Chemical Corp., New York, N. Y. He was previously senior vice president and a director of Celluplastic Corp., Newark, N. J.

American Cyanamid Co., New York, N. Y., has announced the following personnel changes in the plastics and resin division:

W. F. Whitescarver as manager of New York regional sales activities.

H. B. Freeman as manager of Los Angeles regional sales activities.

C. W. Johnson as manager of Chicago regional sales activities.

E. H. Trussell as manager of Boston regional sales activities.

C. T. Byron as manager of Cleveland regional sales activities.

E. K. Hunt as divisional sales manager, succeeding C. J. Romieux.

N. B. Sommer as marketing manager for plastics, including both thermosetting and thermoplastic compounds.

R. G. Head as marketing manager for resins; to include bonding, laminating, coating, and polyester resins.

V. V. Lindgren as technical director of the division.

Russell L. Bauer has been named process engineering supervisor for Mobay Chemical Co., St. Louis, Mo.

G. Allen Lovell, former assistant manager of the mechanical goods division, United States Rubber Co., New York, N. Y., has been elected a vice president and appointed general manager of the division.

Fach Bros., N. Y.

Earle S. Ebers

Earle S. Ebers, former director of research and development, becomes general sales manager for the Naugatuck Chemical Division, United States Rubber Co., Naugatuck, Conn. **D. Yorin Schoene** was promoted from assistant to director of research and development for the division. **F. Dudley Chittenden** has been appointed production manager. He formerly served as factory manager of the division's Painesville, Ohio, plant.

George Wash

George Wash has been advanced to director of the plastics sales division of Phillips Chemical Co., subsidiary of Phillips Petroleum Co., Bartlesville, Okla. He has been associated with the parent company since 1946.

James Young

Bernard M. Hoey

Bernard M. Hoey has been appointed manager of the new Miami, Fla., vinyl extruding plant for Minnesota Mining & Mfg. Co.'s Irvington division. He formerly served as sales manager for the division, which has headquarters in Irvington, N. J.

Howard W. Wing, Jr.

Howard W. Wing, Jr., has been appointed sales manager of the Boltaflex special sheeting division, Bolta Products Division, General Tire & Rubber Co., Lawrence, Mass. He succeeds **J. A. Wilcox,** who becomes manager of Bolta's central sales service.

OBITUARY

Bernard Rifkin

Bernard Rifkin, president of Maryland Plastics, Inc., New York, N. Y., died suddenly on May 9. Born in Russia, he attended night schools in New York City.

In addition to serving as president for Maryland Plastics, Mr. Rifkin held the same position with Philippine Button Corp., Excelsior Pearl Works, Inc., and Manati Pearl Works.

Funeral services were held at the Riverside chapel in New York City, followed by interment in Mt. Lebanon Cemetery, Brooklyn, N. Y. Mr. Rifkin is survived by his wife, Millie, a daughter, and two grandchildren.

New Materials

De-Staticizing Stabilizer

A combination light-stabilizer and de-staticizer, which reportedly prevents darkening and other color changes due to ultraviolet light while simultaneously removing static electricity on all types of plastics, has been introduced by Merix Chemical Co. Called Stabilite, the new chemical is said to be so powerful that an 1/1,000-inch-thick film will filter out 99.8% of incident ultra-violet light at a wave length of 400, and 100% at all wave lengths below 390 millimicrons.

Fully transparent to visible light, Stabilite can be applied by dip, spray, or wipe methods. Maintenance labor costs and replacements are expected to be cut with its use, and pigments formerly unsuited because of their instability to light will offer a wider range of color selection.

For permanent de-staticizing, Stabilite may be diluted 1:1 with water, and 1:10 for temporary action. Non-flammable and practically odorless, the material is approximately neutral in pH. Packaged in gallon and multiple-gallon lots, it de-staticizes and stabilizes about 4,000 square feet of plastics to the gallon.

Readers' Service Item M-1

Mr./Manufacturer
THIS
TOOLPLASTIK
Brochure is
for you
With the handy chart found in this Brochure you will be able to select the right Toolplastik material for your job. You will also see photographs illustrating proven Toolplastik applications. Use this Brochure as a valuable reference to Toolplastik materials, their features and scope of application.
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Supporting Products

Modified Epocast drop hammer die

Modified Epoxy Tool Compound

An impact-resistant epoxy tooling compound reportedly suitable for drop hammer dies has been introduced by Furane Plastics, Inc., Los Angeles, Calif. Designated as a modified Epocast, the formulation consists of 100 parts by weight of Epocast 9-A; 100 parts by weight of Flexibilizer T, which is prepared from a polysulfide liquid polymer manufactured by Thiokol Chemical Corp., Trenton, N. J.; and 10 parts by weight of Hardener HN-9-A.

This compound has been used successfully on drop hammer punch facings in conjunction with Furane's aluminum colored Epocast 4-D. Employed in forming aluminum alloy parts for Douglas Aircraft, a ⅜-½ inch facing of Epocast is applied to the kirksite die body. The punching face of modified Epocast reportedly shows a durometer hardness of 80-95, which offers both resilience and high impact strength.

Readers' Service Item M-2

Half-Second Butyrate Powder

A third, powder form of half-second butyrate for heat sealing applications has been introduced by Eastman Chemical Products, Inc. The material reportedly works well with paper, wood, cloth, and similar porous or semi-porous materials.

Composed of 80% half-second butyrate (Eastman's low viscosity film former) and 20% triphenyl phosphate, the material is said to perform much the same as conventional solvent lacquers and hot melt compositions. Eastman suggests that the sealing machine be operated at about 40-60 psi. and a temperature of 325° F. Blocking occurs at temperatures around 160° F. with only slight pressures. The material is marketed in 50-pound paper bags, and samples are available for test.

Readers' Service Item M-3

Continuous ribbon of processed Sisalana fibers

Sisalana Fiber Fillers

Specially combed and processed Sisalana fiber, long the basis of many ropes and twines, emerges as a decorative reinforcing and strengthening agent in the plastics field. Laminated between layers of flexible or rigid vinyl film and sheeting, the fibers adapt themselves to almost any design conceivable. Plymouth Cordage Co. manufactures the fibers in both continuous lengths and short staples, depending on the desired application.

Sisalana has been used in such molded forms as boats, automobile engine housings, lampshades, furniture panels, blinds, and luggage. Tough and sinewy, the fibers are marketed in different grades and prices, dependent on the quality of the fiber and the degree of processing.

Readers' Service Item M-4

Acrylic Protective Coating

Granules of polymeric acrylic-type ester which may be dissolved or dispersed in many types of organic solvents to produce clear, water-white solutions have been introduced by Rohm & Haas Co. under the trademark Acryloid B-66. Applicable to metal, wood, fabrics, and plastics, these solutions form color-stable protective coatings which are resistant to printing and to hot, soapy water.

Acryloid B-66 is compatible with several types of film formers, yielding films of outstanding adhesion, hardness, flexibility, and fast-drying properties. A typical application is the production of color-stable white enamels. The material dries quickly, and coatings withstand color changes at temperatures as high as 375° F. Superior film adhesion is reportedly obtained from a short bake period at 300° F. Acryloid B-66 is available both in 100% form and as 40% solids in toluol.

Weighing 9.2 pounds per gallon in 100% solids form, the resin can be put into solution on a plant scale with conventional shellac cutting equipment or a tumbling barrel. Compatibility data is available on request.

Readers' Service Item M-5

Vinyl Stabilizing Plasticizer

A stabilizing vinyl plasticizer reportedly showing better compatibility as measured by long-term window exposures, improved ultra-violet durability, and greater resistance to migration than its predecessor, Paraplex G-60, has been developed by Rohm & Haas Co. Designated Paraplex G-61, the material is said to provide exceptionally good heat and light durability in combinations with cadmium and cadmium-barium stabilizers. Physical properties are as follows:

Acid number, mgm., KOH/gm.	1.0
Color, varnish scale	2.0
Viscosity @ 25° C., cps.	2.5-3.5
Specific gravity	0.995
Solidification temperature, °C.	0-5.0

A comparison of performance properties, based on a formulation containing 100 parts vinyl resin, 66 parts plasticizer, and 1.5 parts of a cadmium-barium stabilizer, is included in the following table:

	Paraplex G-61	Paraplex G-60	DOP
100% modulus, psi	1,395	1,320	1,200
Low temperature flexibility, °C.	−21.5	−26.5	−32
Gasoline extraction, %	−16.2	−17.6	−25.1
Soapy water extraction, %	−1.9	−1.9	−2.8
Volatility, activated carbon, %	−0.2	−0.2	−8.8
Heat stability rating	2.0	1.0	10
Light stability rating	1.0	3.0	10

Readers' Service Item M-6

VANDERBILT
MATERIALS
For VINYLS

VANSTAY L

Recommended for Maximum Light Stability and Improved Natural Aging in All Vinyl Resin Compositions.

VANSTAY HT · VANSTAY S

This Combination Provides Excellent Heat Protection for Vinyl Compositions During Processing and in Service.

VANSTAY R

Clear Liquid Heat Stabilizer for Use in Vinyl Compositions.

VANCIDE 89

Non-metallic Fungicide and Bactericide Effective in Vegetable Plasticized Vinyls.

Our Technical Service Representatives Will Gladly Demonstrate the Merits of Our Materials in Your Plant and Assist in Solving Production Problems.

R. T. VANDERBILT CO. INC.
230 Park Avenue, New York 17, N. Y.

New Equipment

Temperature Control System for Batch Polymerizing Kettle

A cascaded control system engineered specifically to regulate the temperature of batch polymerizing kettles has been developed by the Foxboro Co. The key to this system's effectiveness is reportedly the Foxboro Batch Stabilog Temperature Controller, which operates in conjunction with the Foxboro Resistance Dynalog Temperature Controller. Since temperature response is slow, due to the kettles' jacketed construction, a single bulb temperature controller cannot effectively prevent freeze-up and overheating of refrigerant-cooled, exothermic reactions.

In a typical application, the reaction temperature of the plastic monomer is measured by the Batch Stabilog Controller which pneumatically resets the control index pointer of the Dynalog Controller. This, in turn, valves-in the steam and cold water lines circulating through the reactor jacket. The ability of the system to assume control early in the heat-up, throttling the control valves so as to balance out the process, eliminates the danger of overshoot.

Operation of the steam and cold water valves is determined by Valvactor Valve Positioners. The pneumatic output of the controller operates one valve over a 3-9 psi. range, and the other from 9-15 psi. The sequence can be arranged to provide either a small overlap or a gap, if so desired. Addition of the Foxboro "Batch" relay to the standard Stabilog Controller permits the pen to enter the proportional band much earlier in the heat-up cycle, thereby eliminating initial overshoot.

Readers' Service Item E-1

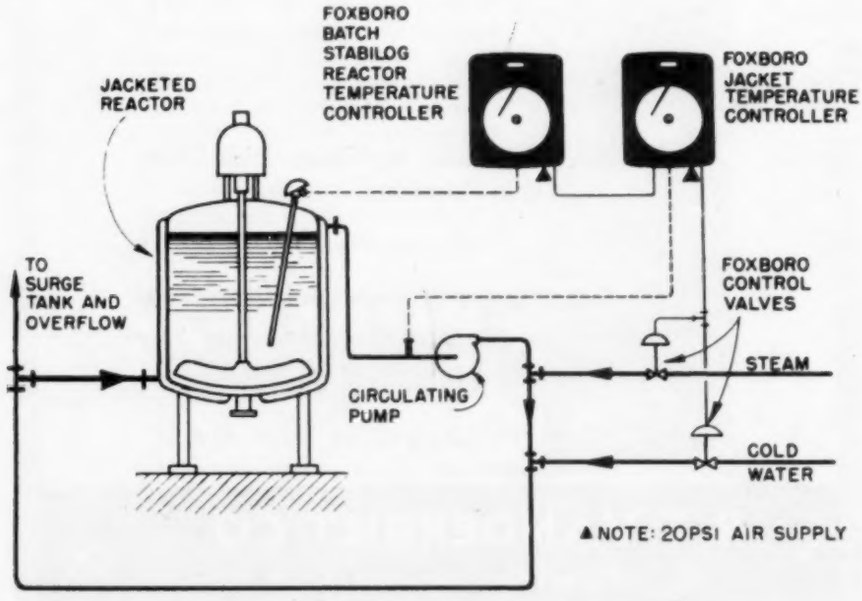
Multiple Purpose Tool

A multi-purpose tool with six Carboloy tungsten carbide cutting edges has been introduced by Rolett Tool & Die Mfg. Co. The tool is designated C5, C6, or C7, depending upon the size of the brazed-on cutting tips which measure, respectively, ⅛ by 9/16-inch, ¼ by ⅜-inch, and ¼ by ⅞-inch.

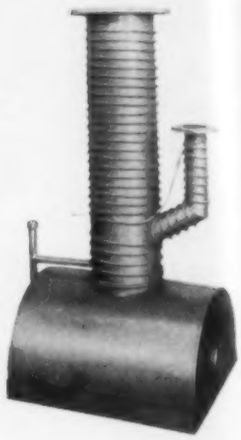
Conveniently pocket-sized, the tool also features a non-slip, knurled, stainless steel shank and a durable, ribbed plastic handle. Uses for the tool include precision scraping of metals and plastics; sharpening of knives, chisels, and other tools; and routing, carving, and marking plastic contours and flats. The tool can be used also as a hand-held lathe tool for cutting ferrous, non-ferrous, and plastic rods and tubes.

Unaffected by the hardest tempered steel, the tip will reportedly scratch glass. The Walter H. Bartz Co., are the distributors.

Readers' Service Item E-2



Typical application of Foxboro control system



Stokes 6-inch Ring-Jet booster pump

Vacuum Metalizing Pumps

A new series of diffusion and booster pumps, reportedly featuring faster pump-down of vacuum metalizing chambers, has been introduced by F. J. Stokes Machine Co., Inc. Referred to, respectively, as the Series 160 and 150 Ring-Jets, the pumps are characterized by having a ring of jets replacing the jet cone found on conventional pumps. This enlarges the air-flow path cross-section, and thereby increases the total air volume and the pumping speed. Size for size, the Ring-Jets are said to increase the pumping speed by 10-100% over pumps of similar dimensions and heat input.

Best performance for the 10,- 14,- and 16-inch Series 160 diffusion pumps is reportedly obtained in the pressure range from 0.1-1.5 microns. This is the critical operating range for vacuum metalizing equipment, and one where maximum speed is necessary. At a pressure of 0.5 micron, the pumping speeds for the above-mentioned pumps are listed at 4,300, 7,300, and 11,000 cubic feet per minute, in that order.

The four- and six-inch Series 150 booster pumps are suited for use with larger metalizing units as supplementary pumps, the latter handling the output of three 14-inch diffusion pumps. It is estimated that the combination will exhaust the 128-cubic-foot chamber of a 72-inch vacuum metalizing unit to the desired pressure of 0.5 micron in less than seven minutes. Specifications and operating characteristics for each size Ring-Jet are available in a series of bulletins just issued by the company.

Readers' Service Item E-3

Temperature Indicating Devices

Two new devices for measuring and permanently recording temperatures from 113-580° F., have been developed by The Paper Thermometer Co. Designated Thermopaper and Thermotube, they consist respectively of graded-series coated papers and sealed-in glass tubes which change irreversibly from white to black at predetermined temperatures. The changes occur

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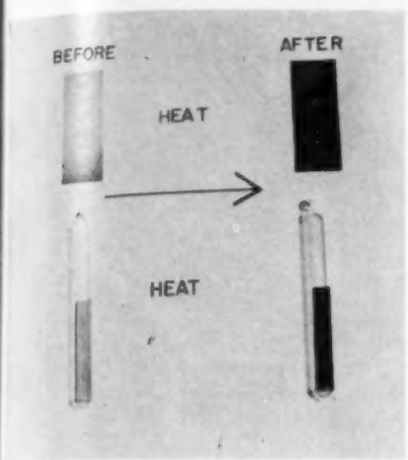


Thermopaper and Thermotube before and after exposure to heat

within a fraction of a second, and are reportedly accurate to within ±1% of the stated temperature.

A thermopaper strip can be placed flat against a clean, dry test surface. If the coating turns black, the object temperature is higher than indicator temperature and a higher temperature paper used. This is repeated until the object temperature is bracketed between two indicator temperatures. Available in over 30 different temperatures, the ⅜ by 2-inch strips are packaged in glass vials. They find application in determining temperatures for brake testing, molds, plastic hot-sealing machines, grids, and in fire prevention.

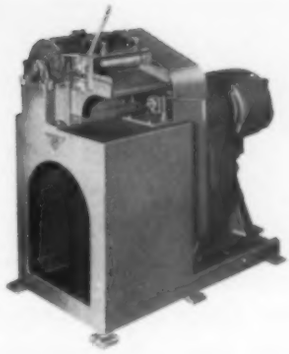
Thermotubes are calibrated to determine temperatures in the range of 115-490° F. They differ from the papers in that, being enclosed, they can be used in inaccessible places or under conditions involving moisture or storage.

Readers' Service Item E-4

Plastic Strip Dicers

A new line of machines for dicing sheets of plastic materials up to ⅛ inch thick and at lineal speeds up to 85 feet per minute has been introduced by Mitts & Merrill, Inc. Designated 6-N-4, 10-N-4, and 14-N-4, the machines handle 6-, 10-, and 14-inch strips, respectively.

The M & M dicers feature notched-knife cutting, with the cutting elements located directly behind and parallel to the feed rolls. This assures smooth flow, material control, and lessens the possibility of irregular pellet formation. Perfect cube shapes are reportedly achieved regardless of the material used. Pellet shape can be altered by changing the knives and/or the lineal speed of flow. Rectangular pellets can be made in dimensions from ⅛ by ⅛-inch by the thickness of the sheet to ½ by ½-inch by the thickness of the sheet. For chopping extruded rods, straight knives rather than notched ones are used.



Mitts & Merrill Plastic Dicer

Machine capacity varies with the particular model, and ranges from 1,600-7,400 pounds per hour. Eight cylinder knives, four straight and four notched, are included as standard equipment. The dicers are operable at 5-20 hp., with speed ratios of 2:1. Overall dimensions of the three machines are quoted as follows: 34 by 28 by 55 inches, 34 by 57 by 56½ inches, and 34 by 65 by 57½ inches. Weights are 1,300, 1,850, and 2,550 pounds, respectively.

Readers' Service Item E-5

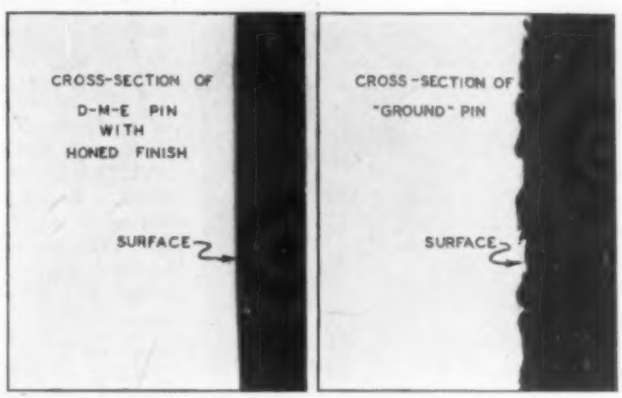
Another Reason Why . . . DME **EJECTOR PINS** *are the Finest Made*

HONED FINISH

REDUCES WEAR and MOLD FLASH

D-M-E Ejector Pins are hot-forged, precision ground, nitrided and THEN HONED . . . to give you the finest finish possible. The photo-micrographs shown here illustrate clearly the result of this added D-M-E feature.

Under magnification of 500 X the so-called "ground" finish pins reveal a saw-like surface which gradually opens up the hole surrounding the ejector pins and eventually causes mold flash. D-M-E's "honed" Ejector Pins, under the same magnification, reveal a smooth finish which reduces wear and costly down time.



The above photo-micrographs were made in an impartial test by the Detroit Testing Laboratory, Inc. of Detroit, Michigan.

42 Standard Diameters from 1/16" to 3/4"

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2355

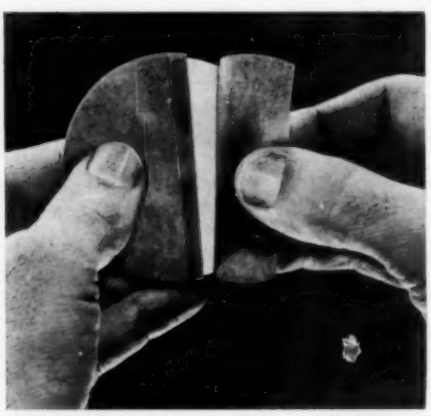
New Products

Patapar Releasing Parchments

Two new types of vegetable parchment for use as protective release backings have been developed by Paterson Parchment Paper Co. Their releasing treatment is non-migratory and reportedly will not cause tack deterioration. They are also resistant to the penetration of oils and softeners.

Patapar 55-35T is used with pressure-sensitive plastic films, tile, and a variety of adhesive formulations. Light blue in color, the parchment contains approximately 6.3 square yards per pound; caliper about 0.004 inch.

Patapar 55-40T is a tough, flexible releasing parchment with heat stability. Also light blue in color, it reportedly releases a large variety of tacky rubber and pressure-sensitive surfaces. Tough and flexible even after repeated cures, the material can be used with all uncured rubbers including Neoprene. Approximately 5.4 square yards are contained in a pound; caliper about 0.004 inch.



Patapar covering protects plastics marker

Readers' Service Item P-1

PVC-Lined Steel Pipe

A new type of pipe made of steel lined with PVC has been developed by Usines a Tubes de la Meuse, Flemalle-Haute, Belgium, for heating purposes and conveying steam in industry, and for surface and under-ground piping for gas, water, steam, etc.

These pipes are said to combine all the advantages of the mechanical properties of steel, particularly its rigidity and impact resistance, with the chemical resistance of PVC. Other plastics, such at tetrafluoroethylene or polyethylene, could be used instead of PVC for the lining, but the latter seems to be the cheapest and also the best-suited for the purpose.

Readers' Service Item P-2

Polyester Protective Coating

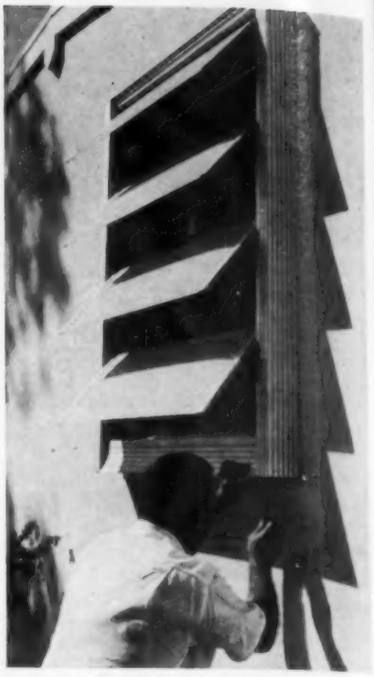
Property data is now available on Metaseal Plastic Coating, a scuff-resistant protective coating for concrete surfaces introduced by American Metaseal Corp. Not a plastic-base paint, but a 100% polyester-styrene copolymer with added pigments for color, the coating contains no solvents and will reportedly outlast any oil-base, rubber-base, and cement paints on concrete surfaces.*

A major problem encountered in outdoor problem is moisture. Ever-present water vapor gets under the paint causing flaking and peeling. Metaseal Plastic Coating is said to have a high water vapor transmission rate which permits any moisture trapped beneath the surface to pass through as vapor.

Requiring no primer, the coating spreads over a given area to provide a thickness twice that of ordinary paints. In addition, the polyester hardens by chemical action, leaving over 85% of the coating on the surface. A thixotropic agent, approximately 2-2.5% by volume, is added for ease of application. The amount of pigment varies with the particular color, averaging 10-12% with lower quantities required for black. Roller spreading is suggested as the most economical means of application. For porous surfaces, a brush should be used afterwards to touch up "thirsty" areas.

* See our June issue, page 309.

Metaseal Plastic Coating being applied to cement floor of industrial plant
Readers' Service Item P-3



Reinforced plastic awning and storm shutter features ease of installation

Reinforced Plastic Awning

A translucent reinforced plastic awning which filters out sun glare and can be closed tightly to form a storm shutter has been introduced by Superior Window Co. Four louvers or vents are set in an extruded aluminum frame which is attached to the outside of a window. These can be adjusted to any angle with a hand-operated control, operable from the inside.

The vents are made from fibrous glass and Vibrin polyester resin, a product of Naugatuck Chemical Division, United States Rubber Co. Shatter-, rust-, and warp-proof, the vents are made rigid by a special stiffening process developed by Russell Reinforced Plastics Corp., which involves creating a pocket in a molded flat sheet and inserting a rod of wood, plastic, or metal to put both skins in tension. This overcomes the poor modulus of tension which would ordinarily ensue.

The awnings are available in several permanent colors to match the color of the house, and in any size up to nine inches wide. Designed for year-round use and ease of installation, the awnings were shown to withstand the force of a hurricane when tightly closed.

Readers' Service Item P-4

Chemfoam Expanded Polystyrene

A new expanded polystyrene called Chemfoam KR is being produced by the Toyad Corp. in slabs measuring 36 by 120 inches in size, with thicknesses of ½-2 inches. The material is reportedly outstanding in thermal insulation efficiency, and is exceptionally light in weight.

Adaptable to buoyant applications owing to its unicellular construction, Chemfoam

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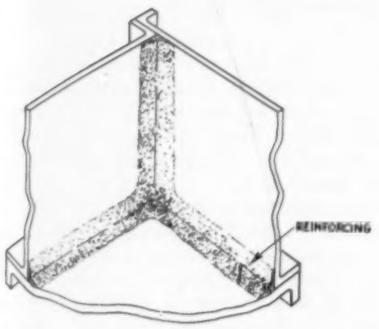
Chemfoam slab measuring 2 by 36 by 120 inches weighs 10 pounds

can be molded to shape and has excellent water resistance. Other suggested applications include packaging and displays.

The foam is marketed with a range of physical properties, as shown by ASTM test methods, since six different materials are available. Specifications are reported as follows:

Density, lbs./cu. ft.	1.8-10
Tensile strength, psi.	30-130
Compressive strength, psi.	15-100
Flexural strength, psi.	60-310
Impact strength, ft. lbs./in., unnotched	2.0-5.5
Thermal conductivity @ 19.9-120° F., lbs./cu. ft.	2.5
Burning rate, in./min.	4.5

Readers' Service Item P-5



Drawing of corner of Modular tank

Reinforced-Plastic Tanks

A line of low-cost, reinforced-plastic tanks has been introduced by Modular Plastics Co. to replace the rubber-lined stainless steel tanks presently used by the plating industry. Molded to customer specifications, the tanks are engineered and stress-analyzed for each particular application.

Electrical connections from the Modular tanks do not require insulation since the glass-reinforced polyester resins used are good dielectric materials. Grounding and short-circuiting dangers from racks and work are eliminated, and drippings and overflow cannot harm the tank exterior.

Construction features include lapped, resin-bonded, reinforced, and bolted joints as safety factors. These are covered with plastic to prevent corrosion, as are the overflow dams and outlet fittings.

Readers' Service Item P-6

Vinyl Picnic Bags

Picnic bags with durable, printed coverings and washable, white liners are available through Fashioncraft Products. Called Thermo-Trav'ler, the bag consists almost entirely of Krene, with the exception of a steel frame support.

The exterior has a fabric-like finish by Victory Plastics in gray, red, green, or tweed. Entirely washable and stain-proof, the bag is designed for ease of handling with ample room for picnic or baby use. Krene vinyl plastics is a product of Bakelite Co.

Vinyl bag interior is easily washed with damp cloth

Readers' Service Item P-7

Vinyl Laminate Printing Plate

Rigid vinyl sandwiched between sheets of aluminum and a thin electrotype make up a new lightweight printing plate reportedly offering a number of advantages to the letterpress printing industry. The process, designated Color-Line, was originated by Printing Plate Supply Co., utilizing an 0.020-inch thick sheet of B. F. Goodrich Chemical Co.'s Geon vinyl cemented to a perforated aluminum base. The thin electrotype plate is placed on top and the entire assembly is heated in an oven. The heated plate is then placed in a cooling press, and 100 tons of pressure applied to force the excess plastic out into the holes in the aluminum backing.

The vinyl sheets are fabricated by Nixon Nitration Works, and are also marketed as sheeting by Printing Plate Supply under the name Electro-Mold. Advantages claimed for the finished plate include ease of production, better register, less press

Front view of two printing plate assemblies showing the electrotype faces on the left of the black vinyl sheets which are cemented to the perforated aluminum backings.

down-time, and longer runs. The process is reportedly advantageous in the stereotyping field, and a plant is presently being equipped to make centrifugal cast stereotypes.

Readers' Service Item P-8

All-Plastic Window Track

What is reported to be the first all-plastic track for aluminum storm and screen windows has been extruded by Streamline Plastics Co., for use with Kota Products, Inc.'s KS No. 2 window. Consisting of Eastman Chemical's Tenite butyrate, the track is said to eliminate sticking and jamming regardless of the temperature.

Each insert panel operates on its own track, and is easily interchangeable from the inside by depressing trigger bolt locks. Kota reportedly finds the plastic track superior to the rubber-plastic combination formerly used.

All-plastic Tenite butyrate window track.

Readers' Service Item P-9

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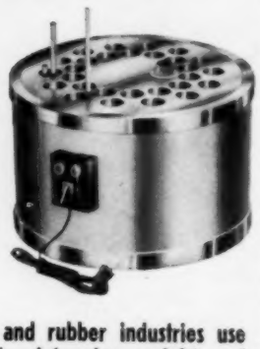

The plastics and rubber industries use this tester to determine weight and shape changes of specimens in compliance with ASTM Specification D-756-50. A complete plug-in unit with built-in heating elements and temperature controls. 28 separate compartments. Also available for oxygen ageing.

Literature upon request

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Corrugated Luminous Ceiling

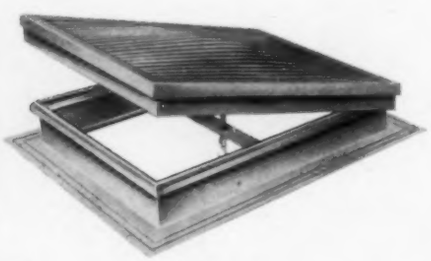
A white, translucent, corrugated PVA sheet for use as a light diffuser in luminous ceiling constructions has been developed by Bolta Products Division, General Tire & Rubber Co., Lawrence, Mass. Called Boltaron LC 9100, the fire-resistant material is said to be shatterproof, and will not crack, craze, warp, or rot.

Decorative as well as functional, the ceiling reportedly eliminates glare and shadow, thus helping to reduce eye strain and worker fatigue. Material properties are as follows:

Thickness, mils	5-9
Light transmission factor, %	48-52
Tendency to static formation	None
Flame spread rating	10
Amplitude of corrugation, in	7-9/16
Corrugations per foot	10-11

Boltaron LC 9100 is marketed in widths from 12-48 inches, and in lengths up to 100 feet. The material is expected to gain wide acceptance in offices, factories, and restaurants.

Readers' Service Item P-10



Manually-operated Marcolite ventilating skylight.

Ventilating Skylights

The Marco Co. has announced the addition of two new ventilating skylights to the Marcolite line of skylights and roof scuttles. Featuring extruded aluminum frames and panels of fibrous glass, the units have self-contained curb and roof flanges, and require no additional flashing.

Two models are available, either manually operated or motorized for remote control, and three overall sizes: 37 by 40½ inches, 49 by 40½ inches, and 61 by 40½ inches. Requiring little or no maintenance and parts replacement, the skylights are easily installed by felt-stripping the roof flange and fastening to the roof deck. The manually-operated model uses a swivel-mount connecting rod and pole to accomplish a fast opening and closing with a minimum of effort.

Readers' Service Item P-11

Plastic Lipstick Container

A swivel-type lipstick container featuring a nylon cover which opens and closes automatically has been designed and patented by State Tool and Die Co. The container itself is molded of styrene, and does not require a removable cap since the lipstick may be exposed or retracted by manipulating a knob at the bottom. Nylon, being strong and flexible, forms a cover which slides back and forth easily over the open end in a synchronized motion.

The new container will hold any lipstick of standard length. Closure design is such that the cover cannot jam regardless of whether a maximum or minimum quantity of lipstick is enclosed. The part is economically produced in single cavity molds using a six-ounce Watson-Stillman injection molding machine.

Styrene lipstick case with sliding nylon cover.

Readers' Service Item P-12

Three-Dimensional Vinyl Panel

The decorative effect of exposed brick is reportedly achieved with Bakelite's rigid vinyl sheet formed in new type three-dimensional panels by Studio Brick, Inc. Designated Studio Brick, the three- by five-foot panels can be cut with a fine-tooth saw or with heavy shears.

The material is applied over plaster or wallboard, using waterproof cement or mastic with small finishing nails. Bricks stand out ½-inch, with a ½-inch space between each mortar joint. Available patterns include: common brick, white panel, classic Roman, and rounded adobe.

Rigid vinyl sheet simulates adobe brick.

Readers' Service Item P-13

Book Reviews

"The Colloid Chemistry of Silica and Silicates." Ralph K. Iler. Cornell University Press, Ithaca, N. Y. Cloth cover, 6 by 9½ inches, 324 pages. Price, $5.50.

Silica and silicates have always existed in great abundance on the Earth, and it is widely believed that they catalyzed the creation of the first life forms by adsorbing asymmetric inorganic molecules which, with the passage of millenia, combined into complex organic molecules eventually capable of reproducing themselves. The subject of the colloid chemistry of silica and silicates, although seemingly a narrow one, is important in such diverse technological fields as geology, mineralogy, agronomy, zoology, and industrial chemistry, and the author has incorporated them all into his discussion of the basic chemistry of these materials. The chapters of the text are admirably organized and efficient, covering, in order of increasing complexity, the silica-water system, the soluble silicates, the chemistry of silicic acid, esters of silicic and polysilicic acid, colloidal silica, amorphous silica gels and powders, colloidal silicates, surface chemistry of silica and silicates, and silica in living organisms. Excellent electron micrographs illustrate the discussion.

"A Professional Look at the Engineer in Industry." National Society of Professional Engineers, 1121 15th St., N. W., Washington, D. C. Paper, 6 by 9 inches, 130 pages. Price, $3.00.

The publication reviews the major causes of dissatisfaction among engineers in industry and the current attitudes toward the development of engineers' unions. The development of collective bargaining organizations of engineers is thoroughly explored, both from the standpoint of legal and historical background and impact on the profession and on management.

The Engineer-in-Industry Committee concludes that the solution must emanate jointly from the professional engineering society and industry, if engineers and management are to resolve their differences without resort to unions which, in the opinion of the vast majority, would reduce their professional status.

Among the suggested remedial steps are a clear-cut distinction between professional and sub- or pre-professional personnel with respect to status, duties, and remuneration; assignment of adequate clerical and technical assistance; elimination of "clock-punching" for professionals; re-evaluation of basic salary policies; and increased use of bonuses for outstanding achievements. All in all, 46 specific areas for improving engineer-management relationships are suggested in the book.

Illustrated charts and tables are included in connection with the economic review. These are documented by more than 250 footnote references.

"British Plastics Year Book 1955." Iliffe & Sons, Ltd., Dorset House, Stamford St., London, England, available through British Publications, Inc., 30 E. 60th St., New York, N. Y. Cloth, 6¼ by 9¼ inches, 652 pages. Price, $5.00.

A classified guide to the plastics industry in the United Kingdom, the 1955 edition is divided into nine sections which are indexed and tabbed for easy reference: Patents, New Companies, and Specifications; Materials; Manufactured Products; Plant and Equipment; Glossary of Trade Names and Terms used in the plastics industry; Names and addresses of manufacturers in the United Kingdom; British Who's Who; Associations and Federations; and Technical and General Data. General and advertisers' indexes are also included.

"Organic Syntheses—Collective Volume III." Edited by E. C. Horning. John Wiley & Sons, Inc., New York, N. Y. Cloth, 6 by 9 inches, 890 pages. Price, $15.

This third collective volume in the series encompasses all the material in Annual Volumes 20-29, and includes corrections, revisions, and seven new checked procedures. The format is generally the same as the individual volumes, with compounds to be prepared, arranged alphabetically. A thumb index provides quick reference to the general index: illustrations; list of solvents and reagents; and the formula, compound, and reaction indexes.

"Practical Plant Layout." Richard Muther. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. Cloth, 8¾ by 11¼ inches, 376 pages. Price, $12.00.

Written for the layout engineer, this how-to-do-it book covers the essential elements of plant layout from four basic points of view: location, over-all layout, detailed layout plan, and installation. Eight contributing factors affecting layout are considered in as many chapters: materials, machinery, manpower, movement, storage, service, building, and change.

Complete directions for collecting data, organizing the layout, installation, checking, and evaluating are given in another section of the text. Management and overseeing are discussed, and numerous practical problems are included to test the understanding of each principal chapter. The book is profusely illustrated with photographs, charts and graphs.

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New Literature

"Air Permeability Apparatus." Bulletin 2262. American Instrument Co., Inc. 4 pages. Described here is the company's device for determining the air permeability of rubber and rubber-like materials. Other available elastomer testing equipment is also pictured.

Readers' Service Item L-1

Publications of Argus Chemical Co.:

"Drapex 3.2 in Electrical Compounds." Technical Data Sheet No. 102. 2 pages. The plasticizer is compared and evaluated with dioctyl sebacate and dioctyl adipate in seven electrical formulations.

Readers' Service Item L-2

"Drapex 3.2 Low-Temperature Epoxy Plasticizer." Technical Bulletin #4. 10 pages. Physical properties, low-temperature flexibility data, plastisol formulations, and results of soapy water extractions are given in this bulletin. Various formulations are suggested, and Drapex 3.2 is compared with other plasticizers as to properties and cost.

Readers' Service Item L-3

Publications of U. S. Industrial Chemicals Co.:

"Petrothene Polyethylene Resins." 12 pages. Methods of preparation of Petrothene 100 and 200 are given, together with properties, applications, processing, and fabrication methods. A complete listing of U.S.I. products and sales offices is included.

Readers' Service Item L-4

"U.S.I. Isosebacic Acid." 5 pages. Formulas, physical properties, specifications, solubility data, and suggested applications for the material mixture are listed in these data sheets. End-uses for compounds made from the acid are also given.

Readers' Service Item L-5

"Lustrex Molding Compounds." Wall chart. Monsanto Chemical Co. Formulations of the five Lustrex molding compounds are compared with respect to particle form, lubrication, cylinder and mold temperatures, heat distortion, and toughness of part.

Readers' Service Item L-6

Publications of Carbide & Carbon Chemicals Co.:

"Carbitol Acetate." Bulletin F-4811A. 4 pages. Physical properties, specifications, shipping data, general solvent properties, and solubility of resins in this glycol-ether, are contained in this bulletin.

Readers' Service Item L-7

"Flexol Plasticizer 810." Bulletin F-8622-A. 6 pages. Physical properties, tentative specifications, performance in vinyl compounds, compatibilities, and net container weights are included in this brochure.

Readers' Service Item L-8

"Flexol Plasticizers." Third edition. 77 pages. A well-illustrated booklet, complete with tables for temperature conversion, vapor pressure variation, etc., it describes the physical properties, specifications, performance characteristics, and numerous applications for the company's line of plasticizers.

Readers' Service Item L-9

"Glycols." F-4763C. 61 pages. The twelve commercial glycols and triols sold by the company are discussed in detail. Developmental products are also described, and physical properties, solvency properties, shipping data, and test methods are tabulated. Thirty-three graphs are included, charting the various physical properties of the glycols.

Readers' Service Item L-10

"Epichlorhydrin." F-8862. 6 pages. Physical properties, shipping data, and reaction formulas for epichlorhydrin, a highly-reactive chemical raw material, are given in this bulletin along with a warning as to its toxicity. A one-page bibliography is included.

Readers' Service Item L-11

"Reconditioned Steel Drums." Bulletin No. 113-D. American Wheelabrator & Equipment Corp. 4 pages. Methods for blast cleaning of steel drums with the company's Wheelabrators are described, along with their advantages over the use of other methods.

Readers' Service Item L-12

"Color Brand Your Products for Life." M. Swift & Sons, Inc. 14 pages. Hot-die stamping techniques with the company's Nu-Hue and Dri-Hue color foils are described in this booklet. Stamping equipment used and applications for the foils are listed. Swift also markets bronze roll leaf, aluminum foil, gold, and metallic colors.

Readers' Service Item L-13

"Pittsburgh Interlock Plastic Wall Tile." Jones & Brown, Inc. 6 pages. A four-color illustrated folder picturing the tiles themselves and rooms finished with the "do-it-yourself" styrene tiles.

Readers' Service Item L-14

"Scriptite 33." PTI 60-5. Monsanto Chemical Co. 3 pages. A melamine-type resin intended for improving the wet-strength properties of papers, Scriptite's properties and applications are listed along with a tabulation of tensile strengths of finished papers.

Readers' Service Item L-15

"The Raffi and Swanson Story." Raffi & Swanson, Inc. 12 pages. This illustrated booklet gives the company's history and describes the newly opened plant and facilities in Wilmington, Mass. The publication coincides with the formal plant opening.

Readers' Service Item L-16

"Unplasticized Polyvinyl Chloride." Sales Service Bulletin #3B. Firestone Plastics Co. 8 pages. Mechanical, thermal, electrical, and chemical resistance properties of commercially prepared unplasticized Exon 402-A are listed in this bulletin. The resin is specifically designed for rigid vinyl fabrications requiring thermoplastic properties.

Readers' Service Item L-17

"Vacuum Forming Molds." Metalmold Forming Co. 4 pages. Three types of materials used by the company in manufacturing male molds for drape forming and female molds for straight vacuum processing are described in detail in this bulletin. These materials are high-strength gypsum cements, thermosetting resins, and sprayed metals.

Readers' Service Item L-18

"Bomb-Lube." Price-Driscoll Corp. 2 pages. Two tables are included on this reference card: the first matches hours per 1,000 cycles with the number of seconds per cycle and the pounds per 1,000 pieces; the reverse table lists general physical properties and comparative weights for commonly used plastic materials.

Readers' Service Item L-19

Abstracts of Important Articles

MATERIALS

"Some Radiation Effects in Long-Chain Polymers," A. Charlesby, *Plastics Inst.*, 23, 52, 133 (April 1955).

Cross-linking by atomic pile irradiation was produced on various polymers and on rubber. Polymers such as polymethacrylate, polyisobutylene, and polytetrafluoroethylene do not cross-link under these conditions, but are reduced in molecular weight by main chain fracture. The possibility of cross-linking polymers under accurately controlled conditions is not only of theoretical interest, but is also assuming practical and industrial importance.

"Properties of Vinyl Resin Plasticizers," Ralph C. Shuey, *Western Plastics*, 2, 5, 17 (May, 1955).

Over 75% of the plasticizers used with vinyl resins fall in three general categories: phthalates, phosphates, and low-temperature plasticizers. A two-page chart is included listing their properties, and test methods for determining these specifications are explained. The basic chemistry of plasticizers is presented, as is a breakdown of production figures for 1953.

"Fatigue Testing of Nonrigid Plastics," R. H. Carey, *ASTM Bull.*, 206, 52 (May, 1955).

In this case, "fatigue" refers to the growth of a crack due to repeated stressing or straining. Four resin-plasticizer systems were tested using the Ross Flexing Machine and the Clash-Berg Torsion Tester. It was shown that fatigue life in non-rigid plastics is primarily a function of applied stress: a five-fold increase in stress producing a ten-fold decrease in numbers of cycles to failure.

"Where do the Techniques of Employing Organic Glasses Stand?" C. R. Schmid and L. Le Marrec, *Ind. Plastiques Mod.*, 7, 3, 13 and 7, 4, 7 (Mar. & Apr. 1955).

Particular reference is to the use of organic glasses in optics. Methods of production, particularly by casting, and of improving properties are discussed, and results of various comparative tests on organic and mineral glasses are given. (In French).

"Paper Chromatographic Studies on the Resinification of Phenol Alcohols," R. Reese, *Kunststoffe*, 45, 4, 137 (Apr. 1955).

A two-dimensional paper chromatographic technique was employed by which the primary reaction products of alkali and acid condensation of phenol-formaldehyde can be largely separated and identified. So far, only low-molecular products with about three phenol residues in the molecule have been identified, but it is thought likely that higher molecular compounds will be included in the future. To explain the individual reactions, pure phenol alcohols were examined by paper chromatography under various reaction conditions. Possibilities for further extending the usefulness of the method are suggested, among which is the use of different solvent mixes. Investigations still to be completed already indicate that a mixture of benzine, acetic acid, and water used with the method improves identification, especially of the low-molecular intermediate products of Novolac formation. (In German).

"The Position of the Polyacrylates among Thermoplastics," C. T. Kautter, *Kunststoffe*, 45, 4, 131 (Apr. 1955).

The properties of polyacrylates and polymethacrylates are compared with those of other plastics in similar applications with a view toward easing the difficulties of selection for the processor and consumer. (In German).

"Value of the Usual Methods of Mechanical Testing of Plastics," D. J. van Wijk, *Plastica*, 8, 4, 188 and 8, 5, 242 (Apr. & May 1955).

After showing that the most important properties of plastics are dependent on time, the author considers the conditions required for the exact determination of these properties. The conventional mechanical tests (tensile, flex and impact strength, hardness, and heat distortion) are critically discussed, and it is concluded that they do not fulfil the stated conditions. Examples of other tests (creep, tension-relaxation, torsion-vibration) are given which yield reliable data on the behavior of plastics as a function of time. (In Dutch).

Requests for copies, reprints, or further information on any article abstracted in this department should be addressed to the publisher of the magazine where the article appeared. A complete listing of the publishers and addresses of these magazines will be printed here quarterly.

—The Editor

"New Physical Research Methods in the Domain of the Macromolecules," M. Piganiol, *Ind. Plastiques Mod.*, 7, 3, 32 and 7, 4, 39 (Mar. & Apr. 1955).

The methods discussed include, among others, infra-red techniques (on polyethylene); nuclear resonance (mentioned as one of the newest and most interesting methods); and apparatus for determining mechanical properties, such as the Ephimeter (for simultaneously measuring elastic modulus and internal friction at variable temperatures and frequencies), the Universal Consistometer, the tonometer, and the micro-calorimeter. (In French).

"Isocyanate Foams," E. J. Mouton, *Plastica*, 8, 3, 126 (Mar. 1955).

The basic materials, their properties and chief applications, and the process for producing isocyanate foams are discussed. A number of manufacturers of the foams in America and Europe, and the trade names under which they market their products, are listed. (In Dutch).

"Plasticized Polyvinyl Chloride," T. Paleologo, *Poliplasti*, 3, 7, 5 and 3, 8, 7 (Jan.-Feb. & Mar.-Apr. 1955).

A comprehensive review of plasticized PVC covering the preparation and properties of the polymers and compounds, as well as the production of finished and semi-finished products. Foams, pastes, latices, lacquers, packaging materials, tubing, fittings, rainwear, upholstery, toys, etc., and various methods of finishing (including welding, sewing, printing, and coloring) are discussed. (In Italian).

"The Physical and Chemical Properties of Polyethylene," J. I. G. Bell, *Canadian Plastics*, 20 (Mar. 1955).

The melt index is not a reliable basis for comparing polyethylenes of different manufacturers. Low-temperature brittleness or environmental crack resistance tests may be useful. Canadian Industries, Ltd. has adopted a method of evaluating the results of Bell Telephone Laboratories' tests to measure resistance of polyethylene to environmental cracking. The variation in mechanical properties of C.I.L. polyethylene with melt index is shown, also typical physical and chemical properties independent of melt index. Included is a guide to the behavior of polyethylene in prolonged contact with various liquids and gases.

"The Properties and Testing of Plastic Materials. Part 2, Section 4 — Impact Strength, Plastic Yield," A. E. Lever and J. Rhys, *Plastics*, 20, 215 (June 1955).

The factors influencing impact test results and the theoretical conclusions are discussed, and various testing methods are compared. Different impact testing machines and their special features are tabulated, and a list of impact strength values for plastics is given.

"True Plastigels Based on PVC," J. Delorme, *Ind. Plastiques Mod.*, 7, 5, 44 (May 1955).

In this concluding article, the author discusses a further advantage that "true" plastigels have over other plastigels or plastisols: they yield finished products of distinctly lower density. Tabulations are given showing the variations in density resulting from the addition of different amounts of gelling agents and fillers, both alone, and in combinations. (In French.)

EQUIPMENT

"Horizontal Pelleting Machines," W. R. Groves, *Plastics Inst.*, 23, 52, 105 (April 1955).

A summary of the main faults of the single-shot type of machine, followed by a discussion of a new design in which the punch and die axis are horizontal and which, it is claimed, avoids all the faults of the vertical machine without introducing any new ones.

"Injection Molding Device for Thermoplastic Compounds," G. Stein, *Plaste u. Kautschuk*, 2, 3, 59 (Mar. 1955).

This device can be connected to available hydraulic presses to permit the production of limited series of larger parts (shots up to 500 grams). A special feature is that the mold is locked by extrusion pressure provided by the special disc spring construction of the sprue bushing. (In German.)

"Machinery for the Processing of PVC," G. Ughetter and C. Colombo, *Poliplasti*, 3, 7, 15 and 3, 8, 22 (Jan.-Feb. and Mar.-Apr. 1955).

The various types of machines used for processing PVC are described, with frequent reference to foreign practice, chiefly American, British, and German. (In Italian.)

PROCESSING

"Manufacture of Cast Sheet and Films," R. Pozzo, *Materie Plastiche*, 21, 4, 296 and 21, 5, 354 (Apr. and May 1955).

After a brief history of the production of plastic film and sheet, there is a detailed description of present casting methods, with the advantages and disadvantages of drum and conveyor belt machines. The application of casting to the older cellulosic materials, as well as to chlorinated rubber, methyl methacrylate, PVC, vinyl copolymers, polyamides, and polytetrafluoroethylene, chiefly in the United States and Germany, is considered. Special reference is made to German wartime use of polyvinyl alcohol in transmission belts. (In Italian.)

"Dimensional Variations in Urea Formaldehyde Moldings," M. Fuzzard, *Brit. Plastics*, 28, 5, 192 (May 1955).

A brief discussion of the effect of dry heat on the linear shrinkage of urea formaldehyde molding, giving results of cyclic humidity exposure tests.

"The Production of Bottles and Other Hollow Goods from Polythene, PVC, and Cellulose Acetate," H. Spies, *Plastverarbeiter*, 6, 1, 3 (Jan. 1955).

A number of drawings illustrate this description of the manufacture of plastic bottles with relatively simple, inexpensive equipment having an output of about 75-180 pieces per hour. (In German).

"Molding Procedure and Mold Design for Melamine-Formaldehyde Materials," J. Butler, *Plastics Inst.*, 23, 52, 113 (April 1955).

The importance of preheating and proper mold design for achieving the desired results in molding melamine tableware are particularly stressed. Also dealt with are the special conditions required in molding mineral-filled melamine formaldehyde.

"The Application of Plastics by the Flame-Spraying Method," R. Kuhfuss, *Poliplasti*, 3, 8, 3 (Mar.-Apr. 1955).

Of the half-dozen classes of plastics that can be flame-sprayed, only the polyamides and polyethylene are considered. The advantages and disadvantages of various designs of apparatus are briefly mentioned, as are method costs and manner of application. (In Italian).

APPLICATIONS

"PVC Piping for Conveying Methane," G. Milani, *Materie Plastiche*, 21, 4, 256 (April 1955).

The problems that had to be overcome in laying rigid Vipla (PVC) piping for conveying methane gas are briefly discussed. (In Italian).

"PTFE - Impregnated Self - Lubricating Bearing Materials," A. G. Thomas, *Rubber & Plastics Age*, 36, 4, 207 (April 1955).

This is a discussion of the preparation and testing of oil-less bearing materials, as described by Dr. A. Blainey. Of three possible methods of impregnating metals, polymerization of tetrafluoroethylene in place, extrusion of the material into the pores of the metal, and impregnation of the sintered metal with finely divided PTFE, the last two proved worthy of trial and have been treated in detail.

"Plastics in the Printing Industry," K. E. C. Buyn, *Plastica*, 8, 4, 180 and 8, 5, 236 (Apr. and May 1955).

A diagrammatic review of graphic reproduction techniques, followed by a description of the applications of various plastics in making negatives, matrix materials, and printing plates. (In Dutch).

"Isocyanates in the Paint and Varnish Industries," E. J. Mouton, *Plastica*, 8, 5, 232 (May 1955).

The raw materials, their properties and applications, and the processing methods used in making polyurethane-based lacquers are reviewed. While the products have many excellent properties, they are dangerous to use and precautions must be taken. Finally, mention is made of the use of urethane oils as binders for plastics. (In Dutch).

"Miner's Lamp of Polyamide," J. Wischerath, *Kunststoff*, 45, 3, 124 (March 1955).

The difficulties involved in the development of a miner's lamp from polyamide are discussed. (In German.)

"Synthetic Resins for Varnishes. 3. Phenol Resins," C. Rothgen, *Kunststoff-Rundschau*, 2, 2, 43 (Feb. 1955). The properties and uses of different types of phenolic resins are dealt with, and some commercial products are mentioned. (In German.)

"Plastic Molding Pads for Forming Light Metal and Steel Plates," H. A. Sagel, *Kunststoff-Rundschau*, 2, 3, 83 (March 1955).

Because of their flow capacity, resistance to aging, and the ease with which they can be repaired, polymerized plastics have proved to be excellent materials for pads used in forming sheet metal. The plastics are also suitable for making the mallets and beaters used in the process. (In German.)

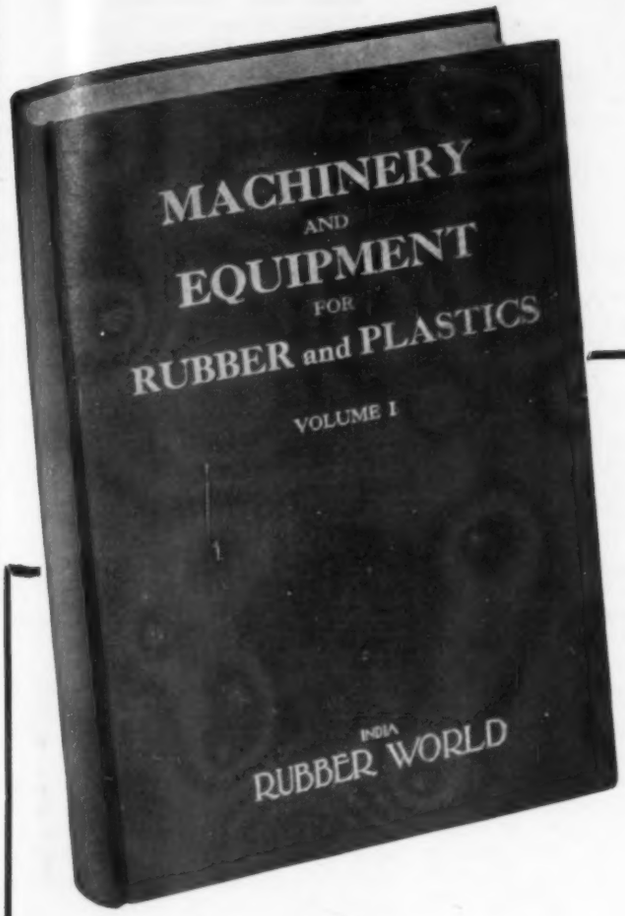
GENERAL

"The Wonder of Plastics," J. C. Swallow, *Plastics Inst.*, 23, 52, 122 (April 1955).

The molecular structures of different classes of plastics and their relation to properties and, in turn, the relation of properties to applications, are presented in simple language.

"Some Promises, Failures and Fulfilments of Plastics," C. A. Redfarn, *Plastics Inst.*, 23, 52, 78 (April 1955).

A historical introduction precedes the outline of the modern progress of plastics from urea-formaldehyde and cellulosics to the newer polymers, including those represented by Terylene, Orlon and Teflon. It is made clear that established plastics are seldom superseded by new plastics, since the latter tend to find their own special fields of application. The developments in molding are then discussed and, finally, the outlook, the author suggesting that survival of Britain will depend to an appreciable extent on the building up of a large, vigorous and enterprising synthetic polymer and plastics industry.



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Patent Digest

MATERIALS

Reaction of Polyureas and Formaldehyde and Hydrolysis, and the Products. No. 2,709,694. Melvin A. Dietrich, Claymont, and Henning W. Jacobson, Wilmington, Del. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

Shaped objects having at least one dimension large with respect to another are prepared by reacting a high molecular weight linear polyurea in solution with a strong, oxygen-containing acid. Formaldehyde is added to form the reaction mixture into the desired shape, and the mixture is coagulated and hydrolyzed by adding a dilute aqueous mineral acid. This eliminates most of the combined formaldehyde, leaving about 0.15% of the urea groups in the form of uron groups.

Vinyl Resin Compositions. No. 2,711,999. John D. Brandner and Robert H. Hunter, Wilmington, Del. (to Atlas Powder Co., Wilmington, Del.).

The plasticized composition consists of a polyvinyl chloride, copolymers of polyvinyl chloride, up to 15% vinyl acetate, and 15-67% primary and secondary plasticizer; the latter being a phenoxyethyl laurate, phenoxyethyl oleate, or a phenoxyethyl tall oil ester.

Epoxide Compositions Containing Halogen. No. 2,712,000. John D. Zech, Wilmington, Del. (to Devoe & Raynolds Co., Inc., Louisville, Ky.).

A halogen-containing resinous solid of polyether polyepoxide formed by mixing polyethers of dihydric phenols, in which a substantial part of the hydroxyl groups are replaced by halogen-containing radicals.

Polymerizable and Polymerized Compositions Comprising an Allylmelamine or Allylisomelamine. No. 2,712,004. Walter M. Thomas, Springdale, Conn. (to American Cyanamid Co., New York, N. Y.).

General formulas are given for three types of melamine compounds and combinations thereof.

Process for Preparing Vinyl Sulfonamide. No. 2,709,707. Harold F. Park, East Longmeadow, Mass. (to Monsanto Chemical Co., St. Louis, Mo.).

Anhydrotaurine is heated rapidly to 300-500° C. at an absolute pressure of less than 100 mm. mercury in order to form vaporous vinyl sulfonamide-containing decomposition products. These are cooled to form a solid vinyl sulfonamide monomer.

Stabilized Chlorine Containing Vinyl Resins. No. 2,711,401. Robert E. Lally, Bedford, O. (to Ferro Corp., Cleveland, O.).

To a chlorine-containing vinyl resin, approximately 0.5-8% by weight of a stabilizer is added; this stabilizer consisting of 1-5 parts carboxylic acid salt and 1-5 parts of an aliphatic polyhydric alcohols, esters, and ethers.

Synthetic Film Comprising a Vinylidene Chloride Copolymer, an Ester Wax, a Long-Chain Polar Compound, and a Calcium Carbonate. No. 2,711,996. Charles H. Hofrichter, Jr., Snyder, N. Y. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

The transparent film comprises essentially a vinylidene chloride copolymer containing 80-94% vinylidene chloride, 0.2-1.0% of a fatty acid containing 16-18 carbon atoms, and 0.05-2.0% of finely divided calcium carbonate. The releasing agent consists of 2-10 parts ester wax, 2-10 parts of the fatty acid, and 0.5-20 parts of the calcium carbonate.

Bis-Carbonic Acid Esters of Glycols as Plasticizers for Polyvinyl Chloride. No. 2,711,997. Hans-Georg Trieschmann, Ludwigshafen, Willibald Ender, Heidelberg, Lothar Reuter, Ludwigshafen, and Waldtraut Froese, Weinheim-Bergstrasse, Germany (to Badische Anilin & Soda Fabrik Aktiengesellschaft, Ludwigshafen, Germany.).

The compound consists of PVC plasticized with a bis-carbonic acid ester containing two chlorinated, saturated aliphatic alcohol radicals.

Cyanoacetic Acid Ester Resins. No. 2,710,850. Thomas Boyd, Springfield, Mass. (to Monsanto Chemical Co., St. Louis, Mo.).

A mixture of 0.5-6 mols of carbonyl compound and one mol of the precipitate obtained by heating cyanoacetic acid and hydrazine are heated to produce a thermosetting condensation product.

Cyanoacyl Hydrazide Resins. No. 2,710,851. Thomas Boyd, Springfield, Mass. (to Monsanto Chemical Co., St. Louis, Mo.).

A mixture of cyanoacyl hydrazide and a carbonyl compound are heated until substantially all of the water and unreacted compounds are driven off, leaving a relatively anhydrous resin.

Printed copies of patents are available from the Commissioner of Patents, Washington 25, D. C. Price, 25c each.

—The Editor

Resins from Cyanoacyl Hydrazides. No. 2,710,852. Thomas Boyd, Springfield, Mass. (to Monsanto Chemical Co., St. Louis, Mo.).

A carbonyl compound is reacted with an iodine-containing cyanoacyl hydrazide to produce a thermosetting resinous heat reaction product.

Preparation of Mixtures of Rubbery Butadiene-Styrene Copolymer with Resinous Copolymer of Vinyl or Vinylidene Chloride. No. 2,711,400. Stuart A. Harrison, Stow, O., and Walter E. Brown, Cambridge, Mass. (to B. F. Goodrich Co., New York, N. Y.).

Vulcanizable material containing a rubber reinforced solely by organic resinous materials is produced by polymerizing a monomer to form an unsaturated rubbery copolymer. This copolymer should contain 50-90% of butadiene-1,3 by weight; the remainder, an alkenyl substituted aromatic compound. An aqueous dispersion of saturated chloroethylene polymer is added, polymerized, and coagulated.

Cellulose Esters Stabilized with a Resinous Polymeric Epoxide and a Metal Salt. No. 2,710,845. Mortimer S. Thompson, Matawan, N. J. (to Hercules Powder Co., Wilmington, Del.).

An aliphatic cellulose ester-containing compound of high heat stability may be prepared by stabilizing the composition with a resinous, polymeric epoxide obtained by condensing an epihalohydrin and a polyhydric phenol. Sufficient metal salt is added to provide the composition with 40-250 ppm.

Polymer Containing Compositions Comprising an Acrylonitrile Polymer, a Thiocyanate, and Water. No. 2,710,846. Melvin A. Dietrich, Claymont, and Alfred F. Smith, Wilmington, Del. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

A solid thermoplastic composition consisting essentially of 18-42% earth or metal alkali thiocyanate, 5-31% water, and 37-75% acrylonitrile polymer. The salt-polymer ratio varies from 3:10 to 10:12, and the salt-water ratio from 1:1 to 5:1.

Acrylonitrile Polymers Dissolved in Dimethyl Methanephosphonate. No. 2,710,847. George E. Ham, Decatur, Ala. (to Chemstrand Corp., Decatur, Ala.).

The new composition comprises a homogenous miscible mixture of 65-95% dimethyl methanephosphonate by weight and 5-35% of a polymer which, in turn, consists of 70% acrylonitrile and 30% of another copolymerizable monomer.

Stabilized Pigmented Cellulose Acetate-Butyrate Molding Compositions Containing Para-Tertiary-Butyl Phenol. No. 2,710,811. George C. De Croes and John W. Tamblyn, Kingsport, Tenn. (to Eastman Kodak Co., Rochester, N. Y.).

A cellulose acetate-butyrate molding compound is stabilized against weathering by the addition of p-tertiary-butyl phenol and a pigment which consists of aluminum powder and the anatase form of titanium dioxide.

Vinyl Chloride Polymers Plasticized with Nonyl Phenyl, 2-Ethyl Hexyl Succinates. No. 2,709,691. Joachim Dazzi, Dayton, O. (to Monsanto Chemical Co., St. Louis, Mo.).

The vinyl chloride polymer is plasticized with an ester in which the alkyl radical attached to the benzene ring has nine carbon atoms.

Cellulose Derivatives Stabilized with Epoxy Condensation Products. No. 2,710,844. Mortimer S. Thompson, Lincroft, N. J. (to Hercules Powder Co., Wilmington, Del.).

Cellulose molding compounds containing at least 8% by weight of trichloroethyl phosphate reportedly gain increased heat stability through the addition of a resinous epoxy condensation product of epichlorhydrin and bisphenol having a boiling point in excess of 350° F., and used in the proportion of 10% by weight.

Epoxy Resins Esterified with Drying Oil, Fatty Acids, and Phosphoric Acid. No. 2,709,690. Eric S. Narracott, Worcester Park, England (to Shell Development Co., Emeryville, Calif.).

A glycidyl polyether of a polyhydric phenol is heated and esterified first with a drying oil fatty acid in the amount of 25-65% of the quantity needed to esterify the polyether completely. Heating is continued with the removal of formed water until the ester has an acid number less than 10, and is devoid of epoxy groups. Further esterification is accomplished with the addition of an aromatic hydrocarbon solvent to which 1-3% orthophosphoric acid has been added.

High-Temperature Polymerization of Unsaturated Hydrocarbon Mixtures. No. 2,709,695. Francis T. Wadsworth, Dickinson, Tex. (to Pan American Refining Corp., Texas City, Tex.).

A normally liquid mixture of unsaturated hydrocarbons obtained in the pyrolysis of a gaseous hydrocarbon is made resinous by adding 0.5% by weight of boron trifluoride in the substantial absence of water and organic oxygenated compounds. At a temperature of over 500° F., a portion is converted into a thermoplastic resin having an iodine number below 80, light color, and superior resistance to decolorization.

EQUIPMENT

Extrusion Apparatus. No. 2,708,771. Ira T. Stoneback, North Caldwell, N. J. (to International Telephone & Telegraph Corp., New York, N. Y.).

An apparatus for extruding a plastic sheath about a wire conductor comprises an extrusion head with an axially extending channel through which the fluid plastic is introduced. An axially disposed core feeds the material into the die where it is heated throughout its course to the tubular extrusion tip.

Means for Making Longitudinally Striped Extrusions of Plasticized Material. No. 2,709,834. Willard J. Johnson, Midland, N. J. (to Louis and Axel Danenberg, Long Island City, N. Y.).

The walls of the die form a discharge orifice of predetermined dimensions. A plurality of spaced intake ports communicate with a channeled passage through which the material courses.

Apparatus for Applying Inserts or Bottoms in Plastic Containers. No. 2,710,986. Robert F. Gray, Kansas City, Mo. (to Injection Molding Co., Kansas City, Mo.).

The apparatus comprises a stationary member positioned between a movable gripping member and a movable heating member. The gripping member extends partially into an opening in the stationary member holding the container in place, and the heating member moves against the opposite end to contact and heat-seal the plastic bottom.

PROCESSING

Method and Apparatus for Extruding Hollow Articles. No. 2,708,772. Leslie John Moncrieff, London, England (to British Celanese, Ltd., London, England).

Rigid tubes are produced by continuously extruding hot, thermoplastic material into tubular form, cooling, and drawing it away from the extrusion point by traction. The tube is contacted only in a region where it is no longer plastic. The cross-sectional shape and size of the tube is controlled by drawing it over a rigidly supported shaping member, which is hollow to permit the passage of compressed air.

Process for Preparing Thin Films. No. 2,710,426. Norbert J. Platzer and Frank A. Carlson, Jr., Springfield, Mass. (to Monsanto Chemical Co., St. Louis, Mo.).

Thin, self-supporting films can be cast from a 40-60% solids aqueous dispersion of a vinyl chloride polymer. The films are simultaneously dried and fused on the casting surface, and then stripped.

Process of Dyeing Aromatic Polyesters. No. 2,710,849. Erhard Siggel, Kleinwallstadt, Germany.

Polyethyleneterephthalate and a soluble indanthrene dye are dissolved in a solvent for both materials to form a homogenous solution, and the polyethyleneterephthalate is precipitated out in colored form.

Manufacture of Articles from a Polymer of Tetrafluoroethylene. No. 2,710,991. Alan Thomas Squires, Allenton, and Clifford George Hannah, Alvaston, England (to Rolls-Royce, Ltd., Derby, England.).

Sheet-like articles having a thickness less than 0.15-inch can be produced by molding preforms at room temperature, heating to a sintering temperature, and cooling. The preforms are molded from a dry powder by spreading a plurality of charges one above the other in the mold and separating them by flexible separator sheets. Pressure is applied to effect consolidation.

Method and Apparatus for Severing and Joining Layers of Thermoplastic Material. No. 2,711,779. Alton H. Carland, Hopkins, Minn. (to General Mills, Inc., Minneapolis, Minn.).

Two thin layers of thermoplastic sheeting are superimposed with their surfaces in parallel face-to-face engagement, and with their free edges projecting in the same direction. They are then cut along a predetermined path and seamed to each other by moving a longitudinal section of electrically-heated resistance wire through both layers.

Method and Apparatus for Butt Welding Thermoplastic Material. No. 2,711,780. Raymond I. Hakomaki, Minneapolis, Minn. (to General Mills, Inc., Minneapolis, Minn.).

The free edge portions are superimposed and melted along the line of the desired weld to form a seam at a point spaced slightly inward from the free edges. The excess material is then trimmed and cooled while the portions are held in the desired coplanar position.

Method for Removing Color Bodies from an Ethyl Cellulose and Stabilizing the Same. No. 2,711,965. George H. Pyle, Hopewell, Va. (to Hercules Powder Co., Wilmington, Del.).

An aqueous solution of a lower aliphatic alcohol is added to an organic solvent-soluble ethyl cellulose with sodium attached to the functional groups. The solution is acidified to a pH of 1.5-3.5 with a strong mineral acid, and washed repeatedly with an unacidified solution of lower aliphatic alcohol. In the final washing, a phenolic stabilizing agent is added to prevent discoloration and viscosity reduction.

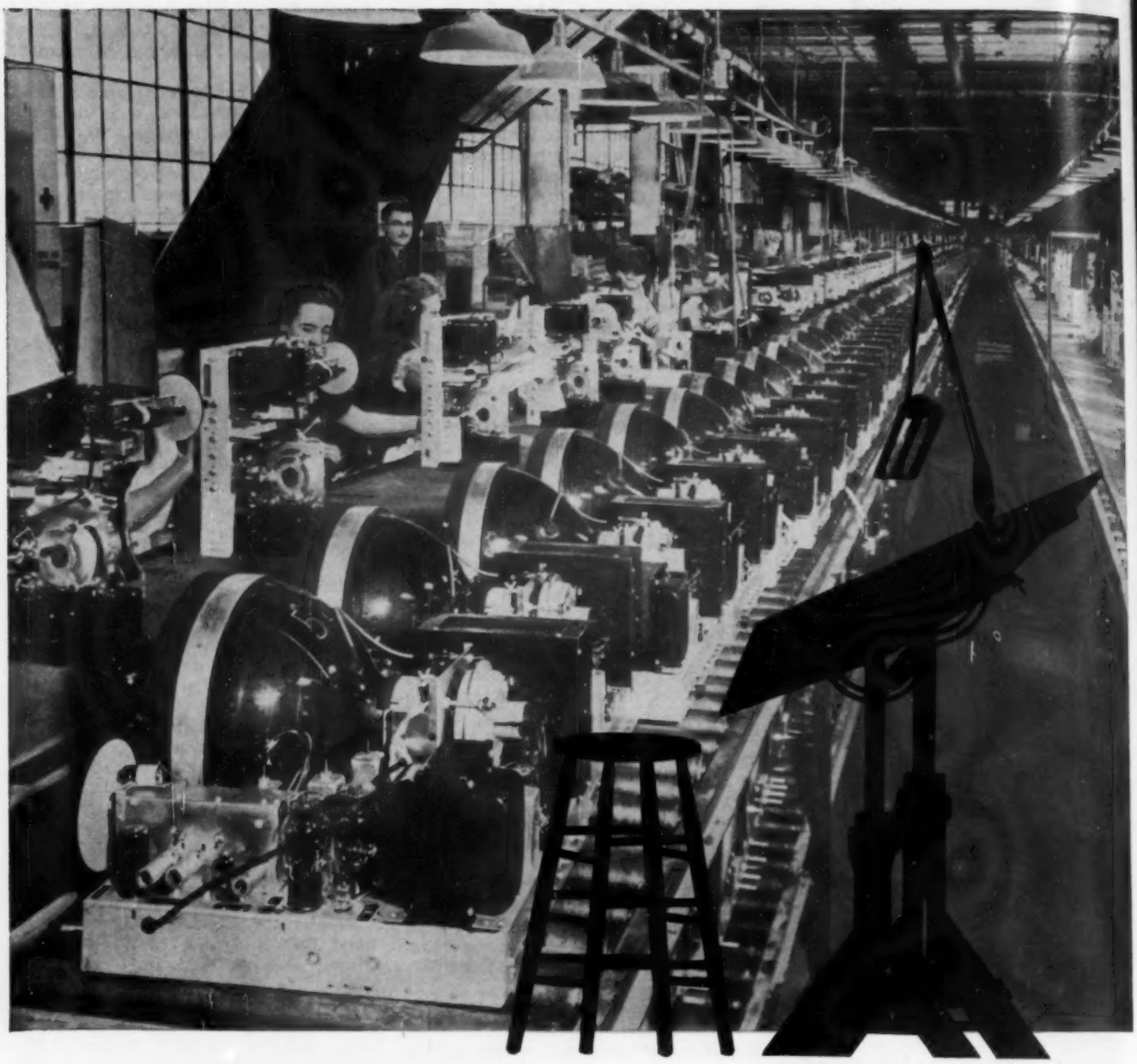
Process for Bonding Polyethylene to Butyl Rubber. No. 2,711,985. Mark W. Olson, Allendale, N. J. (to United States Rubber Co., New York, N. Y.).

A synthetic rubbery copolymer of an isoolefin having 4-8 carbon atoms and containing 0.5-10% aliphatic, conjugated diolefin hydrocarbon is bonded to polyethylene while the rubber is in the uncured state. To effect cure, the polyethylene is held in contact with the rubber surface while heat and pressure are applied.

APPLICATIONS

Plastic Closures. No. 2,709,290. Harry Rosenthal, Peekskill, N. Y.

The plastic closure includes two complemental thermoplastic strips, one having a male closure member forming an integral part of the strip, and the other a female closure. The male comprises a bodily compressible structure ending in a conical, resilient hollow head with an annular recess just beneath. The female is of spherical formation with a central aperture adapted to forcibly engage the recess of the male member. The male head is compressed when forced through, but immediately expands to normal size to form an interlocking closure.



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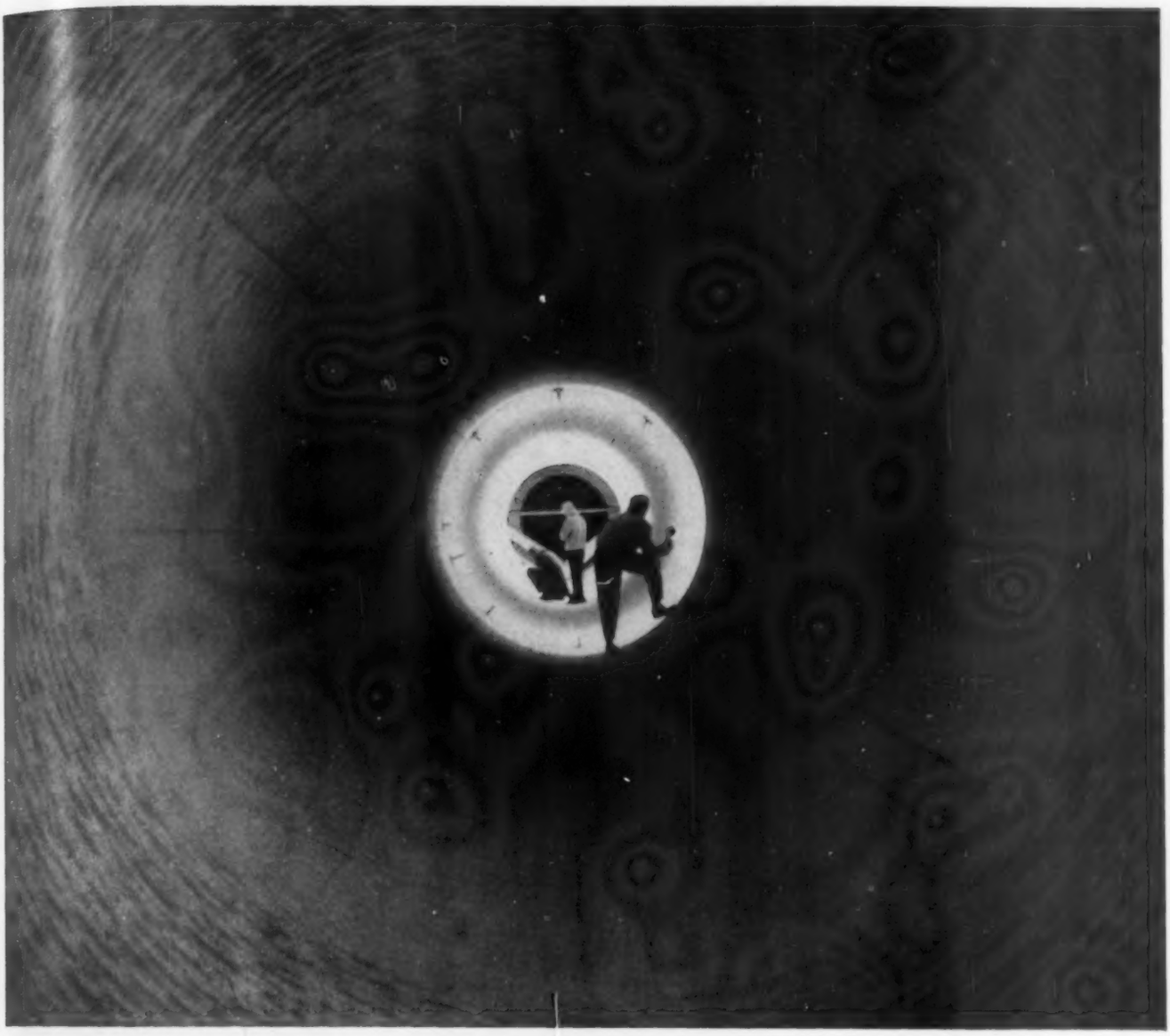

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Domestic Production and Sales of Plastics and Resin Material, February and March, 1955

Following are the partly estimated and revised statistics for the domestic production and sale of plastics and resinous material during the months of February and March, 1955. Units listed are in pounds, dry basis unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily limited to the protective coating industry.

March production and sales figures show a considerable increase over previous months' figures, especially styrenes.

	February		March	
	Production	Sales	Production	Sales
Cellulose Plastics:[1]				
Cellulose acetate and mixed ester:				
Sheets, under 0.003 gage	1,557,880	1,536,209	2,096,467	1,911,420
Sheets, 0.003 gage and over	1,087,250	1,119,631	1,418,896	1,428,079
All other sheets, rods, and tubes	569,860	533,127	765,440	690,386
Molding and extrusion materials	7,177,347	6,950,739	7,422,246	7,046,427
Nitrocellulose sheets, rods, and tubes	364,282	431,677	483,053	523,238
Other cellulose plastics	558,857	606,509	743,534	597,003
TOTAL	11,315,476	11,177,892	12,929,635	12,196,553
Phenolic and Other Tar-Acid Resins:				
Molding materials[1]	16,345,390	15,218,611	19,287,162	17,717,015
Bonding and adhesive resins for—				
Laminating (except plywood)	5,933,601	4,059,861	5,841,494	3,979,687
Coated and bonded abrasives	1,068,126	1,182,690	1,226,943	1,330,063
Friction materials (brake linings, clutch facings, and similar materials)	1,938,200	1,746,276	2,418,310	1,913,971
Thermal insulation (fiber glass, rock wool)	2,997,757	3,066,197	3,545,871	3,719,919
Plywood	4,395,022	3,673,399	3,810,570	3,099,351
All other bonding and adhesive uses	1,080,812	1,105,058	1,274,345	1,295,715
Protective-coating resins, unmodified and modified except by rosin	2,279,802	1,924,877	2,597,956	2,197,794
Resins for all other uses	3,436,283	3,440,805	4,054,342	3,511,882
TOTAL	39,474,993	35,417,774	44,056,993	38,765,397
Urea and Melamine Resins:				
Textile-treating and textile-coating resins	3,288,164	3,394,559	4,189,000	3,875,122
Paper-treating and paper-coating resins	1,763,336	1,821,155	2,088,310	1,928,700
Bonding and adhesive resins for—				
Plywood	7,680,516	6,791,343	8,856,800	8,337,475
All other bonding and adhesive uses, including laminating	2,029,973	2,090,016	2,506,593	2,823,592
Protective-coating resins, straight and modified	2,887,509	2,184,306	3,176,397	2,454,317
Resins for all other uses, including molding	5,914,349	5,857,477	7,315,525	7,431,107
TOTAL	23,563,847	22,138,856	28,132,625	26,850,313
Styrene Resins:				
Molding materials[1]	29,089,219	29,315,737	37,130,688	35,745,732
Protective-coating resins, straight and modified	8,228,063	8,133,571	8,604,501	8,531,184
Resins for all other uses	7,270,514	6,330,022	6,774,473	6,813,338
TOTAL	44,587,796	43,779,330	52,509,662	51,090,254
Vinyl and Vinyl Chloride Resins:[2]				
Polyvinyl chloride and copolymer resins (50% or more polyvinyl chloride) for—				
Film (resin content)		6,606,264		8,052,321
Sheeting (resin content)		4,204,742		4,429,234
Molding and extrusion (resin content)		15,747,702		16,101,543
Textile and paper treating and coating (resin content)[3]		4,828,825		5,401,896
Flooring (resin content)		4,812,067		5,208,125
Protective coatings (resin content)		2,285,463		2,815,044
All other uses (resin content)		3,801,149		4,336,326
All other vinyl resins for—				
Adhesives (resin content)		2,352,688		2,858,828
All other uses (resin content)		7,761,439		8,864,839
TOTAL	51,650,358	52,400,339	59,767,437	58,068,156
Coumarone-Indene and Petroleum Polymer Resins	19,159,530	19,051,034	22,630,619	23,116,836
Polyester Resins:				
For reinforced plastics	3,729,200	2,908,781	5,032,624	3,890,845
For all other uses	131,078	126,075	166,981	262,232
TOTAL	3,860,278	3,034,856	5,199,605	4,153,077
Miscellaneous Synthetic Plastics and Resin Materials:				
Molding materials[1 4]	24,714,283	18,308,354	25,674,557	19,294,85
Protective-coating resins[5]	343,997	239,555	338,668	218,54
Resins for all other uses[6]	8,466,658	12,790,406	11,384,360	17,947,22
TOTAL	33,524,938	31,338,315	37,397,585	37,460,62
GRAND TOTALS	227,137,216	218,338,396	262,624,161	251,701,21

[1]Includes fillers, plasticizers, and extenders.
[2]Production statistics by uses are not representative, as end use may not be known at time of manufacture.
[3]Includes data for spreader and calendering-type resins.
[4]Includes data for acrylic, polyethylene, nylon, and other molding materials.
[5]Includes data for epichlorohydrin, acrylic, polyester, silicone, and other protective-coating resins.
[6]Includes data for acrylic, rosin modifications, nylon, silicone, and other plastics and resins for miscellaneous uses.

SOURCE: United States Tariff Commission, Chemical Division.

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Imagine a vast array of fabric sample "swatches" spread over the product out-put and processing materials of the rubber industry and you have a practical idea of the range of fabric constructions available from Wellington Sears.

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(Industrial News Briefs Cont'd. from page 370)

Borg-Warner Corp., Chicago, Ill., has merged with Byron Jackson Co., Los Angeles, Calif. Both firms will function as independent operating units wth no change in name or management.

Brubaker Mfg. Co., Inc., Los Angeles, Calif., has announced a change of corporate name to Brubaker Electronics, Inc. Corporate entity, management, policies, and locations remain unchanged.

Michigan Panelyte Molded Plastics, Inc., Dexter, Mich., gave a dinner in honor of Roy K. Ferguson and other officials of the parent St. Regis Paper Co., New York, N. Y., and marking the firm's expansion in Michigan. The dinner was held at the Michigan Union, Ann Arbor, on May 19.

Exact Weight Scale Co., Columbus, O., has announced that all four models of their Exact Weight Plastics Weigh Feeders for injection molding machines are now available with completely enclosed housings to eliminate contamination. The mechanism is enclosed on two sides by metal walls; the remaining two sides have clear plastic doors to assure complete visibility and accessibility.

Albert Trostel & Sons, Co., Inc., Milwaukee, Wis., has signed two license agreements with Mobay Chemical Co., St. Louis, Mo., for the manufacture of polyurethane flexible and rigid foams and rubber-like materials. The materials will be produced by Albert Trostel Packings, Ltd., Lake Geneva, Wis., a subsidiary which manufactures hydraulic and pneumatic seals for the automotive, farm implement, and aviation industries.

E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., has begun construction of a project at the Edgemoor, Del., pigments department plant which is designed to increase the production of Ti-Pure titanium dioxide pigments by approximately 25%. The project is scheduled for completion late next year.

The Society of the Plastics Industry (Canada), Inc., has announced a change of address to 77 York St., Toronto 1, Ont. The telephone number remains unchanged.

Dow Corning Corp., Midland, Mich., has named J. F. Dellaria special coordinator between its silicone development laboratories and those of the aircraft industry.

E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., has announced that its nearly 90,000 employes worked a total of 177,256,000 hours during 1954 with only 57 lost-time injuries, for an injury frequency rate of 0.33 per million man-hours. The safest year in company history, it represents a 40% improvement over 1953.

Westinghouse Air Brake Co., Air Brake Division, Wilmerding, Pa., has named DeWitt L. Shelly manager of its new special products group which will specialize in manufacture, assembly, and test of general industrial apparatus and components, including pressure tanks, precision gears, electronic chasses, molded rubber and plastics, and grey iron, brass, and aluminum castings.

O'Hara-Rowan Associates, Bassett Building, Summit, N. J., has announced a change in corporate name and location to Parkway Plastics, Inc., 393 South 21st St., Irvington, N. J. Parkway specializes in plastic packages, squat jars, tools, and molds.

Pittsburgh Coke & Chemical Co., Pittsburgh, Pa., has announced that its diisooctyl phthalate plasticizer, PX-108, has been approved for use in non-toxic vinyl formulations. This enables manufacturers to use it in the production of film for food wrappings, and in intravenous vinyl tubing.

NOTICE

PLASTICS TECHNOLOGY will buy back-issues, at 50 cents per copy.

*

February, April & May numbers are completely exhausted.

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CALENDAR of COMING EVENTS

September 6
SPE Southern California Section, Scully's Restaurant, Los Angeles, Calif.

September 21
SPE New York Section, Gotham Hotel, New York City.

September 28
Reinforced Plastics Group, SPE New York Section, Tufaro's Restaurant, Corona, N. Y.

September 29
Fort Wayne Rubber & Plastics Group, Van Orman Hotel, Fort Wayne, Ind.

November 14-15
TAPPI National Plastics Meeting, Brooklyn, N. Y.

Current Market Prices

This listing is as comprehensive and up-to-date as possible. The full listing will appear quarterly, while intervening issues will carry a briefer tabulation of price changes and additions.

Companies whose products do not appear are invited to submit price data for inclusion in the listing. All suppliers are requested to submit product additions and price changes promptly as they occur, in order to make this listing of maximum value to our readers.

Prices, in general, are f.o.b. works. Ranges indicate quantity or grade variations. No guarantee of these prices is made, and spot prices should be obtained from the individual suppliers.

—The Editor

Adhesives

Ampcoflex Adhesive	qt.	$2.75 / $3.50
Bakelite BC—17613	lb.	.54 / .84
BCU-40	lb.	.18 / .48
BR-11938	lb.	.285 / .585
Bonding resins, abrasives	lb.	.20 / .915
Brake linings	lb.	.215 / .6275
Foundry resins	lb.	.2075 / .395
Heat Insul. resins	lb.	.1425 / .37
CD Cement Nos. 200, 201, 202, 203, 204	qt.	$0.94 / $1.50
PS-7	qt.	2.12 / 2.90
Epoxy Adhesive A-1, A-3		
A-4	qt.	4.45 / 6.90
A-2, A-5	qt.	5.60 / 8.00
A-6	qt.	5.80 / 8.00
C-1, C-2, C-3, C-9	qt.	5.60 / 8.00
C-4, C-7	qt.	3.69 / 5.30
Flexible Resin No. 1	qt.	4.45 / 6.90
G-E 12316	lb.	.2975/ .3975
Melmac 401	lb.	.45
421	lb.	.45 / .47
Melurac 300, 302	lb.	.25 / .29
301	lb.	.28 / .33
Melbond 2002-14	qt.	1.84 / 5.00
4021 Type I	sq. ft.	1.43
Type II	qt.	1.29 / 3.20
Type III	qt.	1.49 / 3.50
Plaskon Phenolic Bonding Resin	lb.	.16 / .21
Urea Adhesive 530-11L	lb.	.1875/ .2175
Liquid Adhesive, 2L Types	lb.	.105 / .115
WR Types	lb.	.0675/ .125
Spray Dried Adhesives	lb.	.18 / .29
Plastic Cement	gal.	2.25 / 2.70
Polyester Foam Cement PC-232	gal.	2.40 / 2.90
Schenectady SP-7401	lb.	.29 / .31
Schwartz Vinyl Cement	qt.	1.24 / 1.50
Thixons	gal.	3.30 / 9.00
Urac 110	lb.	.205 / .225
115	lb.	.24 / .26
180	lb.	.095 / .12
185	lb.	.1625/ .2175
186	lb.	.0875/ .1125
192	lb.	.07

Anti-Static Agents

Anstac-2M	qt.	1.75 / 2.00
Logostat	gal.	1.35 / 1.65
Merix Anti-Static	qt.	1.60 / 4.00
Stabilite	lb.	.355 / 1.75

Catalysts

Advacel	lb.	.4375/ .5375
Aritemp Curing Agent 105	lb.	2.00 / 2.25
Bakelite BH-17618	lb.	.33 / .63
BHU-53	lb.	.15 / .45
ERL series	lb.	.67 / 1.195
Cadet benzoyl peroxide, granules	lb.	.98 / 2.00
Paste	lb.	.95 / 2.25
Powder	lb.	1.50 / 2.37
Dichlorobenzoyl peroxide	lb.	3.00 / 4.25
Lauroyl peroxide	lb.	1.90 / 3.50
Methyl ethyl ketone peroxide	lb.	1.85 / 4.00
Catalyst 57	lb.	.12
196	lb.	.10
C-110, -180, -180-S, C-110-S, WF-100, -101	lb.	.12
Curing Agent A	lb.	3.00 / 6.75
B	lb.	3.00 / 4.75
Furane H-736-A	lb.	1.30 / 2.00
Hardener 157	lb.	1.00 / 1.15
175, 179, 191	lb.	.50 / .65
181, 184, 185, 185-S, M-325	lb.	.12
342	lb.	1.40 / 1.55
H C Promoter 6%	lb.	.5275/ .6275
12%	lb.	.9025/ 1.0025
HN 551	lb.	.95 / 1.40
901	lb.	.36 / .80
951 Ciba	lb.	.82 / 1.32
951 Furane	lb.	1.30 / 2.00
IC activators		3.00
Inhibitor	lb.	.98
Melurac 255, 259	lb.	.35
Modifier CB-110, WF-61	lb.	.15
Plaskon Hardeners, Liquid	lb.	.07
Powdered	lb.	.10 / .46
Spray dried	lb.	.10 / .25
Promoter D-2	lb.	1.60 / 2.00
SA Hardener	lb.	.10
Shell ditertiary butyl peroxide	lb.	1.965 / 2.92
Soligen	lb.	.4825/ .5825

Coating Resins

Bakelite Phenolics	lb.	.28 / .64
Styrene emulsions	lb.	.1375/ .31
Vinyl acetates	lb.	.295 / .66
Solutions	gal.	5.10
Alcohols	gal.	2.27 / 2.76
Butyral resins	lb.	1.04 / 1.24
Chlorides	lb.	.41 / .61
Chloride-acetates	lb.	.38 / .66
Modified	lb.	.44 / .72
CD Strip A	qt.	1.13 / 2.10
Dylex K-500, -600, -700, -900	lb.	.30 / .46
Kel-F Dispersion (dry wt.)	lb.	12.00
Plaskon Alkyds	lb.	.1075/ .3375
Modified	lb.	.15 / .2625
Ester Gums	lb.	.1425/ .2475
Maleics	lb.	.1825/ .275
Melamines	lb.	.195 / .435
Phenolics	lb.	.3925/ .475
Modified	lb.	.1825/ .29
Phenolic Laminating Varnishes	lb.	.165 / .27
Silicone Alkyds	lb.	1.10 / 2.40
Ureas	lb.	.195 / .435
Polyfluoron liquid dispersions	lb.	2.65 / 3.85
Paste dispersions	lb.	4.20 / 4.40
Primer 140	qt.	7.88 / 8.25
Schenectady Alkyds SA Type	lb.	.3575/ .38
SE Type	lb.	.3675/ 1.435
SEA Type	lb.	.3575/ .38
Styrenated	lb.	.22 / .2625
Maleics	lb.	.1725/ .23
Phenolics	lb.	.2325/ .53
Modified	lb.	.1825/ .275
Schwartz AT-25	qt.	.63 / 1.00
BE-40	gal.	3.80 / 3.95
Synvaren 631	lb.	.17 / .25
Synvarite BRLD	lb.	.39 / .45

Colors

Acheson 0100 Series Paste Dispersions		
Blacks	lb.	.50 / .81
Blues	lb.	.55 / 2.175
Green	lb.	2.51 / 2.69
Orange	lb.	.67 / .85
Reds	lb.	1.08 / 1.34
White	lb.	.52 / .70
Yellows	lb.	.57 / .75
Aquablaks	lb.	.085 / .235
Cabot carbon blacks	lb.	.05 / .79
Cadmolith Reds	lb.	1.72 / 2.20
Yellows	lb.	1.12 / 1.20
Claremont 4000-series Pastes		
Blacks	lb.	.82 / 1.01
Blue	lb.	.80
Browns	lb.	.65 / 2.30
Greens	lb.	.80 / 2.15
Orange	lb.	1.58
Red	lb.	4.15 / 4.80
Silver	lb.	1.02
White	lb.	.695
Yellows	lb.	.65 / 2.87
D-Series pastes,		
Blacks	lb.	.47 / .68
Blues	lb.	.62 / 1.55
Golds	lb.	2.31 / 2.49
Green	lb.	1.86 / 1.88
Oranges	lb.	.70 / 3.65
Reds	lb.	1.10 / 2.57
Silver	lb.	.89 / .91
Whites	lb.	.45 / .60
Yellows	lb.	.55 / 1.68
K-Series pastes,		
Blacks	lb.	.58 / .71
Blues	lb.	.91 / 1.40
Browns	lb.	.53
Greens	lb.	.94 / 1.41
Metallics	lb.	.91 / 2.47
Orange	lb.	.80 / 3.84
Reds	lb.	1.03 / 5.07
Violet	lb.	2.30
Whites	lb.	.59 / .60
Yellows	lb.	.73 / 3.02
Codispersions	lb.	.23 / .24
Covinylblaks	lb.	.68 / 1.145
Cowaxblaks	lb.	.4075/ .6075
Cyanamid dyes, calcozines	lb.	.81 / 5.57
Nigrosines and indulines	lb.	.59 / .97
Oils	lb.	.62 / 7.29
Inorganic pigments		
Blues, cobalt	lb.	.305 / .35
Iron	lb.	.51 /
Ultramarine	lb.	.165 / .325
Greens, chrome	lb.	.39 / .44
Oranges, chrome	lb.	.32
Molybdate	lb.	.45
Yellows, chrome	lb.	.32
Zinc	lb.	.26
Organic pigments		
Blues, alkali, dry	lb.	2.10
Flushed	lb.	1.20
Molybdated & tungstated	lb.	2.60 / 6.10
Phthalocyanine	lb.	.90 / 3.60
Greens, mol. & tung	lb.	3.20 / 6.20
Phthalocyanine	lb.	1.71 / 3.95
Oranges	lb.	.70 / 3.00
Reds, bon	lb.	1.50 / 2.00
Chlorinated	lb.	1.20
Lithols	lb.	.85 / .90
Naphthols	lb.	.80 / 3.60
Paras	lb.	1.05
Rhodamines	lb.	4.25 / 6.13
Toluidines	lb.	1.60
Yellows	lb.	.56 / 2.25
Ferro blues, browns, greens	lb.	.90 / 2.96
Reds	lb.	2.93 / 4.75
Yellows	lb.	.91 / 2.90
Harwick, blues	lb.	1.55 / 4.55
Brown	lb.	3.00
Greens	lb.	1.55 / 4.50
Oranges	lb.	1.05 / 1.25
Reds	lb.	1.20 / 3.53
Yellows	lb.	.85 / 4.50
Interchemical IC Series		
Black	lb.	.56
Blues	lb.	.75 / 2.10
Browns	lb.	.64 / .69
Greens	lb.	.90 / .99
Oranges	lb.	.78 / .89
Reds	lb.	1.16 / 2.50
White	lb.	.70
Yellows	lb.	.95 / 1.65
IVO bone blacks	lb.	.16 / .2175
Kentucky inorganics, orange	lb.	.44 / .64
Yellows	lb.	.31 / .66
Organics, blues	lb.	3.00 / 4.15
Greens	lb.	3.50 / 4.60
Purple	lb.	1.85 / 2.05
Reds	lb.	1.95 / 3.85
Kriegr-O-Dip W Types	qt.	2.63 / 7.80
A Types	qt.	1.52 / 2.25
Laminac color pastes	lb.	.76 / 1.90
Mapico blacks	lb.	.135
Browns	lb.	.145
Tans	lb.	.21
Yellows	lb.	.1125/ .1175
Mearlmaid Pearls	lb.	14.00 / 25.00
Nacromer Pearls, Series C	lb.	2.15 / 2.25
Series W	lb.	1.50 / 1.60
Plastic Color, blacks	unit	.75 / 1.40
Blues	unit	.65 / 1.10
Brown	unit	1.20
Greens	unit	.65 / 1.00
Reds	unit	.65 / 2.50
Whites	unit	.80 / 1.30
Yellows	unit	1.15 / 1.55
PMS polyester colors	lb.	.85 / 2.85
Polystyrene colors	lb.	.65 / 4.30
Polysupra polyethylene blues	lb.	.65 / 5.60
Blacks	lb.	.50 / .80
Browns	lb.	1.48 / 3.30
Greens	lb.	1.82 / 3.55
Ivory	lb.	.65 / 1.00
Purples	lb.	2.10 / 3.30
Reds	lb.	.70 / 6.30
Silver	lb.	1.50 / 2.95
White	lb.	.60 / .85
Yellow	lb.	1.45 / 4.25
Polystyrene blues	lb.	.50 / 9.20
Blacks	lb.	.50 / 5.30
Browns	lb.	.95 / 2.55
Greens	lb.	.35 / 7.40
Ivory	lb.	.85 / 1.20
Reds	lb.	.35 / 6.40
White	lb.	.60 / 1.05
Yellows	lb.	1.45 / 2.95
R-C blacks	lb.	5.50 / 21.30
Browns	lb.	4.375 / 15.75
Reds	lb.	.28 / 15.05
Yellows	lb.	3.60 / 14.05
Rez-N-Dye (dry wt.)	lb.	7.50
Saran colors	lb.	.59 / 1.80
Sherwin-Williams Dispersed Colors	lb.	.55 / 1.97
Inorganic colors, orange, yellows	lb.	.32 / .45
Organic colors, blues	lb.	.90 / 3.60
Greens	lb.	1.35 / 3.95
Reds	lb.	.85 / 4.40
Yellows	lb.	.55 / 1.97

Vinylized colors, blacks, whites	lb.	.755	
Blues	lb.	1.16 /	1.18
Golds	lb.	1.51 /	1.57
Green	lb.	1.45	
Metallic	lb.	1.15	
Orange	lb.	.83	
Reds	lb.	1.15 /	2.27
Yellows	lb.	.76 /	1.09
Vlolite 199, green	lb.	2.95	
200, yellow	lb.	3.75	
PL 3-60, blue	lb.	3.25	
18-70, blue	lb.	3.70	
Witcobinks	lb.	.075 /	.37
Zopaque, anatase	lb.	.225 /	.235
Rutile	lb.	.245 /	.255

Dispersing Agents

Daxads	lb.	.08 /	.40

Fillers

Cab-o-sil	lb.	.68 /	.75
Calcene NC	lb.	.036 /	.059
TM	lb.	.0375/	.0625
Cotton flocks	lb.	.12 /	.32
Dixie Clay	ton	14.00 /	34.50
Edgar ASP 200	ton	43.00	
900	ton	18.50	
1300	ton	80.00	
Harwick clays	ton	14.00 /	57.00
Flock	lb.	.11 /	.28
Magnesia	lb.	.105 /	.13
Mica	lb.	.075 /	.0825
Pecan Shell Flour	ton	80.00 /	100.00
Stan White 325	ton	8.50 /	11.00
Walnut Shell Flour	ton	55.00 /	100.00
Hi-Sil 101	lb.	.10 /	.155
233	lb.	.09 /	.105
Hydrite	ton	22.50	
Flat	ton	22.50	
PD-10	ton	46.50	
Kalite	ton	50.00 /	65.00
McMamee Clay	ton	13.50 /	33.00
Multifex MM	ton	110.00 /	125.00
Nytal 200L	ton	27.00 /	50.00
300	ton	37.00 /	60.00
Silene EF	lb.	.06 /	.105
Surfex MM	ton	37.00 /	52.00
Suspenso	ton	33.00 /	48.00
Witcarb P	ton	110.00 /	140.00
R	ton	120.00 /	150.00
Regular	ton	56.75 /	85.00
Wollastonite F-1	ton	23.00 /	25.00
P-1	ton	25.00 /	27.00

Finishes

Toy Gloss T-11 H	gal.	2.75 /	4.45
Logoquant colors	gal.	3.35 /	11.95
Silk screens	gal.	1.50 /	6.11
Logoset Series W	gal.	1.72 /	7.64

Flame-Proofing Agents

IC-776 Antimony Concentrate	lb.	.495 /	.51
M&T Antimony Oxide	lb.	.27 /	.285
Flame Retarder	lb.	.29 /	.305

Lubricants

Baselube	qt.	2.50 /	4.00
Bomb-Lube	lb.	1.35 /	1.95
DC-36 Emulsion	lb.	1.36 /	2.50
Garalease 915	gal.	3.80 /	4.50
HSC 435	lb.	1.36 /	1.48
IC-500	gal.	2.50	
-571	gal.	3.25	
-793-10	gal.	3.40	
Lunn-Lease	gal.	4.15 /	4.85
M-1 Mold Release	lb.	3.00 /	4.00
Metasap barium stearate	lb.	.37 /	.42
Calcium 627	lb.	.36 /	.41
Stearate	lb.	.35 /	.40
Magnesium stearate	lb.	.38 /	.43
Mold-Ease Concentrate PCR	qt.	2.50 /	5.85
Mold Release 225	gal.	5.25 /	6.00
235	gal.	6.00	
Mold-Wiz	gal.	4.00 /	6.00
Part-A-Part	gal.	3.05 /	3.75
Partingkote No. 823	qt.	1.18 /	4.36
Prepoxy No. 832 A	qt.	2.85 /	3.00
Plastik Parting Fluid No. 829	qt.	2.18	
Releasor Wax No. 826	lb.	2.29	
Sprits	lb.	1.00 /	1.25
SS-452	gal.	2.80 /	4.90
Toplube	qt.	2.50 /	4.00
Vibrin-VPA Parting Agent	gal.	4.25 /	4.65

Miscellaneous

Advaresin C X F	lb.	.49 /	.55
K F	lb.	.40 /	.46
Dutch Boy Bentone	lb.	.44 /	.60
Ben-A-Gel	lb.	.98 /	1.40
Metasap Water Proofing Agent 569	lb.	.21	
PMS Purging Compound	lb.	.35	

Molding Compounds & Resins

Acrylic

Cadco cast rods	lb.	1.83 /	6.96
Polished	lb.	1.99 /	7.16
Machined rods	ft.	22.00 /	89.54
Tubes	lb.	1.39 /	5.76
Polished	lb.	1.51 /	5.99
Colors	lb.	1.62 /	5.99
Pearl	lb.	1.99 /	6.76
Lucite injection molding powders:			
Colorless, transparent	lb.	.68 /	.80
Std. colors	lb.	.72 /	1.00
Compression molding powders	lb.	.65 /	.75
Plexiglas molding powders:			
Colorless	lb.	.65 /	.835
Colors, stock	lb.	.69 /	.885
Custom	lb.	.69 /	1.035
Sheets, Types I-A & II			
Colorless	sq. ft.	.80 /	23.88
Colored	sq. ft.	.88 /	1.82
Type R: colorless	sq. ft.	.60 /	1.04
Colored	sq. ft.	.87 /	1.33

Alkyd

Plaskon foundry resin 580-11L	lb.	.245 /	.275
Molding compound, Type 411	lb.	.43 /	.60
Type 413, 417	lb.	.57 /	.74
Type 420 black	lb.	.44 /	.695
Type 422 colored	lb.	.51 /	.695
Mottle	lb.	.52 /	.705
Natural	lb.	.49 /	.60
Type 430	lb.	.34 /	.50

Cellulosic

Cellulose acetate:			
Ampacet Group I	lb.	.50 /	.59
Group II	lb.	.46 /	.53
Group III			
Colors	lb.	.50 /	.59
Metallic	lb.	.63 /	.71
Pearl	lb.	.59 /	.68
Phosphorescent	lb.	.80 /	.89
Celanese film rolls			
Clear	lb.	.64 /	.87
Colors	lb.	.88 /	1.74
Sheets			
Clear	M. sq. in.	.032 /	.107
Colors	M. sq. in.	.042 /	.141
Lumarith molding cmpds., Group I	lb.	.50 /	.59
Group II	lb.	.46 /	.55
Group III	lb.	.36 /	.45
Sheeting, extruded, non-stock			
Clear	lb.	.12 /	1.89
Colors	lb.	.15 /	2.07
Stock, clear	M. sq. in.	.12 /	1.62
Colors	M. sq. in.	.14 /	1.62
Cast, rolls			
Clear	M. sq. in.	.125 /	.558
Matte	M. sq. in.	.179 /	.648
Tinted	M. sq. in.	.239 /	.708
Sheets, clear	M. sq. in.	.141 /	1.52
Matte	M. sq. in.	.203 /	.788
Tinted	M. sq. in.	.255 /	1.72
Hercocel A, extrusion & injection	lb.	.50 /	.65
Injection, std. colors	lb.	.46 /	.61
Special colors	lb.	.42 /	.45
Tenite Acetate, Group 1	lb.	.50 /	.59
Group 2	lb.	.46 /	.55
Group 3	lb.	.41 /	.51
Group 4	lb.	.38 /	.49
Group 5	lb.	.65 /	.75
Cellulose acetate butyrate:			
Tenite butyrate	lb.	.62 /	.71
A pearls	lb.	.72 /	.81
Blacks, reprocessed	lb.	.50 /	.58
Ethyl cellulose:			
Dyeform 720, 721	lb.	1.29 /	1.52
Ethocel P. G.	lb.	.72 /	.80
Bulk, reg.	lb.	.66 /	.81
Std., 7 cps.	lb.	.71 /	.86
Hercocel E	lb.	.72 /	.88

Epoxy

Araldite 502, 6010, 6020	lb.	.80 /	.995
504	lb.	.77 /	.965
551, 6060	lb.	.75 /	.95
6030, 6040	lb.	.885 /	.995
Bakelite ERL series	lb.	.80 /	.995
Epocast 2, 3, 5	lb.	1.33 /	1.77
4-B-2, 4-B, 4-C, 4-C-T, 4-D, Paste	lb.	1.15 /	1.55
Epon 828	lb.	.80 /	1.21
834	lb.	.90 /	1.56
864	lb.	.91 /	1.44
864-C-75	lb.	.73 /	.74
1001	lb.	.615 /	1.56
Furane CN-502	lb.	1.33 /	1.77
Jet-Kote (with cat.)	gal.	7.50 /	10.00
Rezolin L-900	lb.	1.33 /	2.19
L-910	lb.	1.42 /	2.19
L-930	lb.	1.51 /	2.19
L-940, -941, -942	lb.	1.52 /	2.19

Fluorocarbon

Bakelite FGBB-33789, FGEB-34790, FXMA-50590, FXMB-50344	lb.	9.00 /	10.00
FGEB-32788, FXMB-50090	lb.	12.00 /	14.00
FYTD	lb.	11.00 /	13.00
FYTH, FYTS	lb.	8.50 /	9.50
Kel-F Grade 270, 300 High density	lb.	9.00 /	10.00
Low density	lb.	8.50 /	9.50
Grade 300-P25	lb.	10.00 /	11.00
Polyfluoron, high density crystals & pellets	lb.	9.00 /	9.50
Colors	lb.	9.50 /	10.00
Low density powder	lb.	8.50 /	9.00
Dispersion grade	lb.	10.50 /	11.00
Teflon powder, dispersion	lb.	7.00 /	7.75
Fine	lb.	9.50 /	11.00
General	lb.	5.10 /	5.75
Tape cylinder	lb.	5.35 /	6.00

Melamine

Fiberite 2016	lb.	.95	
Melmac 402	lb.	.51 /	.53
404R 404T	lb.	.85 /	.95
405	lb.	.45 /	.52
428	lb.	.48 /	.55
430	lb.	.465 /	.535
440	lb.	1.10	
480	lb.	.265 /	.315
1077, 1079	lb.	.47 /	.75
1500	lb.	.42 /	.55
1502	lb.	.45 /	.58
3020	lb.	.57 /	.72
3024-A	lb.	.67	
3135	lb.	.90 /	1.10
P-592, -592-A	lb.	.65 /	.75
Plaskon	lb.	.44 /	.75

Phenolic

91-LD	lb.	1.50 /	2.50
Admirez PL-50	lb.	.215	
UP-11	lb.	.2325	
Bakelite general purpose	lb.	.187 /	.3525
BMG-5000	lb.	.19 /	.30
Colors	lb.	.2375/	.435
Chem. resist.	lb.	.23 /	.40
Electrical Insul.	lb.	.2725/	.415
Heat resist.	lb.	.19 /	.35
Impact resist.	lb.	.24 /	.4025
Barrett foundry resins, liquid	lb.	.2125/	.2425
Powdered	lb.	.27 /	.355
Insulation resins	lb.	.15 /	.175
Molding resin 313, 314, 317	lb.	.27 /	.285
316	lb.	.295 /	.31
1502, -3, -4, -5, R-110R	lb.	.25 /	.265
R-114	lb.	.285 /	.30
Corfoam 107, 114	lb.	.55 /	.82
Cyacor 151	lb.	.215 /	.235
191	lb.	.13 /	.16
Durez, heat resist.	lb.	.19 /	.245
Impact resist.	lb.	.24 /	.63
Insulation	lb.	.21 /	.305
Non-Bleed	lb.	.19 /	.195
Special	lb.	.19 /	.665
Std.	lb.	.19 /	.245
Durite GP	lb.	.195 /	.24
HR	lb.	.191 /	.3025
IM	lb.	.24 /	.415
SG	lb.	.195 /	.3575
Fiberite 1078	lb.	.42 /	.43
1087, 1165, 1270, 1271, 1330, 1332, 1347, FM 1132, FM 3510	lb.	.39 /	.395
1153	lb.	.455 /	.46
1167	lb.	.3875/	.3925
1340	lb.	.4275/	.4325
1346	lb.	.44 /	.4475
4010	lb.	.68	
4020	lb.	.815 /	.82
FM 926	lb.	.43 /	.435
927	lb.	.41 /	.415
1914	lb.	.375 /	.38
1957	lb.	.445 /	.45
1996	lb.	.375 /	.38
10365	lb.	.5225/	.5275
11547	lb.	1.05 /	1.06
11678	lb.	.52 /	.525
14111	lb.	.415 /	.42
17067	lb.	.851 /	.82
17610	lb.	1.05 /	1.06
G-E 12316 foundry resin	lb.	.2975/	.3975
12368, 12374, 12392 shell mold	lb.	.26 /	.36
12408, 12460, 12490, 12491, 12493, 12853, 12863, 12875 12460	lb.	.19 /	.20
12420, 12439	lb.	1.05 /	1.15
12430, 12817, 128882	lb.	.20 /	.21
12432	lb.	.39 /	.395
12433	lb.	.55 /	.555
12435	lb.	.235 /	.24
12439, 12466	lb.	.26 /	.36
12444	lb.	.42 /	.425
12462	lb.	.50 /	.505
12463	lb.	.40 /	.405
12467	lb.	.50 /	.60
12486	lb.	.195 /	.20
12487, 12489 rubber-phenolic	lb.	.355 /	.36
12494 rubber-phenolic	lb.	.375 /	.38
12495	lb.	.24 /	.245
12808 rubber-phenolic	lb.	.49 /	.495
12809 rubber-phenolic	lb.	.65 /	.655
12824	lb.	.49 /	.495
12841	lb.	.2375/	.2425
Loven LHR-401, -403	lb.	.225 /	.23
-407, -409	lb.	.60 /	1.00
-408	lb.	.25 /	.255
LI201	lb.	.39 /	.40
-207	lb.	.475 /	.48
-209	lb.	.60 /	1.00
-212	lb.	.425 /	.43
LM-110, -119	lb.	.19 /	.195
-101	lb.	.24 /	.245
-116	lb.	.255 /	.26
-117	lb.	.225 /	.23
-118	lb.	.1975/	.2025
LMI-301	lb.	.2525/	.2575
-303	lb.	.345 /	.35
-304	lb.	.60 /	1.00
-307	lb.	.3075/	.3125
LMM-801, -803	lb.	.2125/	.2175
-804, -811	lb.	.245 /	.25
-807	lb.	.215 /	.22
Marblette casting resins	lb.	.50 /	.60
Plenco foundry resins	lb.	.27 /	.35
Molding cmpds. gen. purpose	lb.	.185 /	.235
Heat resist.	lb.	.19 /	.24
Improved impact	lb.	.225 /	.28
Min. bleed	lb.	.185 /	.195
Radio & TV	lb.	.20 /	.215
Stock	lb.	.205 /	.34

Kelly general purpose	lb.	.195 /	.20
Heat & impact resist.	lb.	.20 /	.205
Leahox, gen. purpose, heat resist.	lb.	.19 /	.20
Impact	lb.	.245 /	.3125
Low elec. loss	lb.	.30 /	.355
Special	lb.	.20 /	.24
Rogers RX-425	lb.	.28 /	.385
-426	lb.	.3425/	.3475
-428	lb.	.34 /	.455
-429	lb.	.35 /	.46
-431	lb.	.4075/	.53
-442	lb.	.3325/	.3375
-448	lb.	.34 /	.345
-458	lb.	.365 /	.37
-525	lb.	.28 /	.285
Schenectady shell mold resins	lb.	.26 /	.28
Soolplastik No. 8000	lb.	.48 /	.72
Polyamide			
A.M.I. Polyamide 115	lb.	1.13 /	1.33
Spirel molding powder	lb.	1.435 /	1.60
Polyester			
Atlac 363E-02Z, -12Z	lb.	.66 /	.69
-32Z	lb.	.68 /	.71
382E	lb.	.57 /	.60
FP	lb.	.66 /	.69
Bakelite Polyester resins	lb.	.35 /	.75
Dial 50-01, -51	lb.	3.00 /	3.50
51-01	lb.	.76 /	.90
52-01	lb.	1.88 /	2.50
52-20-30	lb.	1.30	
Herron	lb.	.43 /	.485
C-312, -400, -514, -548, -625, -730, -800	lb.	.35 /	.385
-312-2	lb.	.365 /	.38
-336, -382, -706	lb.	.37 /	.385
-401	lb.	.44 /	.455
-420	lb.	.355 /	.37
-433	lb.	.38 /	.395
-636, -670	lb.	.48 /	.495
-638, -689	lb.	.55 /	.565
-670-2	lb.	.50 /	.515
-671	lb.	.405 /	.42
Filled resins	lb.	.255 /	.54
4111	lb.	.45 /	.465
4119	lb.	.43 /	.445
4120	lb.	.40 /	.415
4128	lb.	.37 /	.385
4134	lb.	.46 /	.475
4146	lb.	.43 /	.445
4192	lb.	.365 /	.38
4202	lb.	.55 /	.565
Mylar, rolls, types A & C	lb.	2.50 /	4.80
Type D	lb.	3.00 /	3.50
Sheets, type A	M. sq. in.	.09 /	1.11
Type C	M. sq. in.	.09 /	.15
Type D	M. sq. in.	.53 /	1.34
Plaskon 911, 920	lb.	.55 /	.665
941, 942, 951, 9411	lb.	.35 /	.465
943	lb.	.41 /	.525
9404	lb.	.365 /	.48
9406	lb.	.355 /	.465
9500, 9510, 9511	lb.	.35 /	.465
9600	lb.	.44 /	.555
Pre-Imp	lb.	.68 /	.85
Thermaflow 100T	lb.	.62 /	1.05
120	lb.	.89 /	1.25
200T, 300T	lb.	.62 /	1.05
400T, 500T	lb.	.70 /	1.10
Vibrin No. 112	lb.	.40 /	.515
114, 117, 118, 151, 152	lb.	.35 /	.465
115A	lb.	.38 /	.495
121	lb.	.46 /	.573
135	lb.	3.00	
142	lb.	.55 */	.665
152	lb.	.365 /	.48
X-1029	lb.	.35 /	.465
X-1055B	lb.	.62 /	.73
X-1633A	lb.	.49 /	.605
X-1636W	lb.	.585 /	.70
Polyethylene			
A-C No. 6, 617	lb.	.30 /	.37
No. 6A, 7, 617A	lb.	.35 /	.42
No. 615, G-201	lb.	.38 /	.45
No. 629	lb.	.40 /	.47
No. 729	lb.	.45 /	.52
Alathon	lb.	.41 /	.505
Bakelite DE Series	lb.	.43 /	.725
DYGT	lb.	.54 /	.69
DYLT, DYNF, DYNH	lb.	.41 /	.59
DYNJ	lb.	.44 /	.62
DYNK	lb.	.45 /	.63
Celanese film, rolls	lb.	.61	
Sheets	M. sq. in.	.033 /	.257
Sheeting, rolls	lb.	.85 /	.98
Sheets	lb.	.98 /	1.15
Poly-Eth 1003	lb.	.44 /	.58
1005, 1007	lb.	.41 /	.55
Reynolon 1000, P series	lb.	.60 /	.80
Tenite Group 1	lb.	.41 /	.45
Group 2	lb.	.43 /	.47
Group 3	lb.	.46 /	.50
Group 4	lb.	.39 /	.43
Group 5, 6	lb.	.50 /	.72
Group 7	lb.	.60 /	.82
Group 8	lb.	.70 /	.92
Silicone			
Bakelite GMGA-5001, -5002	lb.	2.75 /	3.10
5003	lb.	4.00 /	4.35
5004	lb.	5.40 /	5.75
Styrenes			
Ampacet, crystal	lb.	.315 /	.335
Colors, std.	lb.	.345 /	.365
Special	lb.	.345 /	.75
Pearl	lb.	.41 /	.75
Phosphorescent	lb.	.695 /	1.00
Tinsel	lb.	.41 /	.67
Confetti	lb.	.51 /	.70
Bakelite BMC series, nat.	lb.	.45 /	.685
Colors	lb.	.50 /	.735
BMS, SMD series, crystal	lb.	.295 /	.31
Colors, std.	lb.	.335 /	.35
Special	lb.	.335 /	.52
RMD series, nat.	lb.	.45 /	.685
Colors	lb.	.50 /	.735
TGD series	lb.	.33 /	.35
Colors, std.	lb.	.36 /	.38
Special	lb.	.36 /	1.00
TMD series	lb.	.33 /	.40
Colors, std.	lb.	.36 /	.43
Special	lb.	.36 /	1.00
Catalin, high impact, natural	lb.	.325 /	.355
Colors, std.	lb.	.355 /	.385
Special	lb.	.36 /	1.00
Medium impact, natural	lb.	.325 /	.355
Colors, std.	lb.	.355 /	.385
Special	lb.	.355 /	1.00
Regular grade, crystal	lb.	.305 /	.325
Colors, std.	lb.	.345 /	.365
Special	lb.	.345 /	1.00
Utility black	lb.	.18 /	.235
Cycolac 12769 A, 12877, 12968, 12982	lb.	.73 /	.81
12803	lb.	.65 /	.73
12830, 12967	lb.	.70 /	.78
12876 A	lb.	.69 /	.77
12981	lb.	.78 /	.86
12983	lb.	.76 /	.84
12984	lb.	.77 /	.85
13022	lb.	.72 /	.80
Darex Copolymer 3	lb.	.47 /	.67
43G, X34	lb.	.42 /	.61
Latices 3L, 34L, 616L	lb.	.335 /	.48
610L	lb.	.30 /	.46
Dow Latex, polystyrene	lb.	.30 /	.46
Latices, styrene/ butadiene	lb.	.30 /	.46
Dylite, expandable beads	lb.	.50 /	.60
Koppers, Fibertuff	lb.	.55 /	1.505
MC-185 series	lb.	.33 /	.355
-300 series	lb.	.33 /	1.005
-400 series	lb.	.355 /	1.005
Regular, crystal	lb.	.295 /	.315
Colors, std.	lb.	.335 /	.355
Special	lb.	.335 /	1.005
Pearl	lb.	.41 /	1.005
Phosphorescent	lb.	.695 /	2.005
Kralastic, std. colors	lb.	.50 /	1.10
Lustrex HI-Flow 55, crystals	lb.	.295 /	.31
Hi-Test 88, std.	lb.	.36 /	.38
Special colors	lb.	.36 /	1.00
L, crystals	lb.	.295 /	.31
Colors, std.	lb.	.335 /	.35
Special	lb.	.335 /	1.00
LHA, std.	lb.	.355 /	.375
Special	lb.	.355 /	1.00
Utility black, gen. purpose	lb.	.18 /	.185
High impact	lb.	.235 /	.24
Medium impact	lb.	.19 /	.195
Marbon resins	lb.	.39 /	.46
Plio-Tuf G75C, G85C	lb.	.52 /	.55
Styron 475, natural	lb.	.33 /	.35
Colors, std.	lb.	.36 /	.38
Special	lb.	.36 /	1.00
Sheets, std.	lb.	.55 /	.60
Special	lb.	.55 /	.62
480, natural, black	lb.	.38 /	.40
Colors, std.	lb.	.41 /	.43
Special	lb.	.41 /	1.00
647, crystal	lb.	.305 /	.32
Colors, special	lb.	.345 /	1.34
666, 688, crystal	lb.	.295 /	.31
Colors, std.	lb.	.335 /	.35
Special	lb.	.335 /	1.00
700, crystal	lb.	.295 /	.31
Colors, std.	lb.	.335 /	.35
Special	lb.	.335 /	1.00
777 colors, std.	lb.	.355 /	.375
Special	lb.	.355 /	1.00
Urea			
Admirez SP-30	lb.	.27	
UP-50	lb.	.105	
Beetle C-4980, T-298	lb.	.1875/	.30
MUP series, powder	lb.	.30 /	.49
Special colors	lb.	.30 /	.59
Granules	lb.	.33 /	.52
Special colors	lb.	.33 /	.62
Plaskon molding cmpds.: Colors, single	lb.	.1875/	.30
Special	lb.	.30 /	.62
Standard	lb.	.30 /	.52
Foundry resins, liquid	lb.	.10 /	.13
Powdered	lb.	.2325/	.2525
Vinyls			
Bakelite QG-5909	lb.	.37 /	.605
Colors	lb.	.42 /	.655
QG-5921	lb.	.43 /	.665
5924	lb.	.45 /	.685
QYNA, QYSM, QYSQ	lb.	.31 /	.51
QYNV	lb.	.34 /	.54
QYSJ	lb.	.35 /	.55
VG-1914, 1918	lb.	.39 /	.625
1985	lb.	.37 /	.605
5507	lb.	.33 /	.565
5544	lb.	.425 /	.66
5911	lb.	.335 /	.57
Colors	lb.	.385 /	.62
5980	lb.	.34 /	.575
9031	lb.	.285 /	.52
Colors	lb.	.335 /	.57
9530	lb.	.295 /	.53
Colors	lb.	.345 /	.58
VAGH	lb.	.55 /	.75
VMCH	lb.	.42 /	.62
VYDR, VYNW	lb.	.31 /	.51
VYHH	lb.	.35 /	.55
VYLF	lb.	.37 /	.57
VYNS	lb.	.45 /	.65
VYNV	lb.	.32 /	.52
Blacar No. BW-60	lb.	.315 /	.385
NEMA colors	lb.	.355 /	.425
No. BW-80	lb.	.405 /	.455
NEMA colors	lb.	.445 /	.495
No. PC white, ivory, black	lb.	.285 /	.335
Other colors	lb.	.325 /	.375
Darex Everplex A (wet wt.)	lb.	.21 /	.39
B (wet wt.)	lb.	.22 /	.40
G (wet wt.)	lb.	.21 /	.39
Copolymer Y (wet wt.)	lb.	.245 /	.28
PVA Emulsions (wet wt.)	lb.	.19 /	.355
Diamond PVC-45, -50	lb.	.38 /	.44
Dow PVC-100, -111	lb.	.38 /	.57
Exon 402A, 450, 468, 500, 900A, 905, 915, 925	lb.	.38 /	.56
400XR-61	lb.	9.75	
470	lb.	9.55	
471	lb.	9.50	
654 plastisol	lb.	.41 /	.59
700XR-59 latex	lb.	.38 /	.44
Formvar	lb.	.865 /	1.03
Gelva emulsions	lb.	.19 /	.205
Granules	lb.	.4175/	.6175
Geon color masterbatches	lb.	2.00 /	2.75
Extrusion cmpd. 2042, white ivory	lb.	.375 /	.61
NEMA colors	lb.	.425 /	.66
2046 black	lb.	.375 /	.61
6373 black, white, nat.	lb.	.42 /	.655
NEMA colors	lb.	.47 /	.705
6461 black, white, nat.	lb.	.465 /	.625
Colors	lb.	.515 /	.675
8550 transparent	lb.	.54 /	.67
8600 black, white, ivory	lb.	.405 /	.565
NEMA colors	lb.	.455 /	.615
8620 black, white, ivory, brown	lb.	.405 /	.565
Gray, green, red	lb.	.455 /	.615
8630 black, white, nat.	lb.	.565 /	.725
Colors	lb.	.615 /	.775
8650 black, white, nat.	lb.	.44 /	.60
8656 black, nat.	lb.	.565 /	.725
8677 black	lb.	.545 /	.705
8720 black, gray, nat.	lb.	.735 /	.895
8737 black, nat.	lb.	.435 /	.595
8740 black, white, nat.	lb.	.405 /	.565
Latex 151, 251	lb.	.34 /	.40
351	lb.	.38 /	.44
352	lb.	.36 /	.42
552	lb.	.415 /	.475
576	lb.	.39 /	.45
652	lb.	.41 /	.47
Molding cmpd. 8372 black, white	lb.	.405 /	.64
Colors	lb.	.455 /	.69
8539 black, white, gray, nat.	lb.	.42 /	.655
Colors	lb.	.44 /	.675
8640	lb.	.435 /	.67
8643	lb.	.405 /	.64
8679, 8726, 8727, 8728, 8729, 8731	lb.	.42 /	.655
Polyblends	lb.	.475 /	.575
Resin 101, 101EP, 103EP, 126, 202, 205, 400X65, 400X74L, 400X78	lb.	.38 /	.56
121	lb.	.41 /	.59
200X20	lb.	.42 /	.60
404HI	lb.	.43 /	.61
400X80	lb.	.46 /	.64
400X10	lb.	.44 /	.62
Goodrich PVC Plastisols (dry wt.)	lb.	.38 /	.72
Krene, film	lb.	.56 /	.71
Sheeting	lb.	.55 /	.66
Marvinols	lb.	.38 /	.54
Opalon dry blends	lb.	.33 /	.72
Profile extrusion cmpds.	lb.	.37 /	.805
Resin 300	lb.	.38 /	.56
410	lb.	.41 /	.59
Wire cmpds.	lb.	.33 /	.77
Plastiflex, std.	lb.	.90 /	1.10
Novelty	lb.	1.15 /	1.50
Pliovic resins	lb.	.38 /	.40
Reynolon, 4000 series	lb.	1.55 /	2.30
Rolls, 1-mil	sq. yd.	.0625/	.11
Colors	sq. yd.	.0675/	.08
4-mil	sq. yd.	.215 /	.3125
Colors	sq. yd.	.2375/	.255
16-mil	sq. yd.	.81 /	1.19
Colors	sq. yd.	.86 /	.945
Satinflex	lb.	1.15 /	1.50
Vinylidine			
Dow Latex 744-B	lb.	.30 /	.46
Saran formulation 115, black, nat.	lb.	.39 /	.52
Colors	lb.	.44 /	.69
720 nat.	lb.	.41 /	.54
Colors	lb.	.46 /	.71
747 nat.	lb.	.395 /	.525
761 nat.	lb.	.39 /	.52
Colors	lb.	.44 /	.69
820 nat.	lb.	.42 /	.55
Colors	lb.	.47 /	.60
Latices	lb.	.45 /	.61
Resin F 120	lb.	.58 /	.65
Plasticizers			
Adipol 2EH, 10A, 810, XX	lb.	.425 /	.455
BCA	lb.	.45 /	.475
ODY	lb.	.47 /	.50
Barrett dibutyl phthalate	lb.	.30 /	.34
Dimethyl phthalate	lb.	.275 /	.315

Iso-octyl-iso-decyl phthalate	lb.	.305 /	.345
Benzoflex 2-45	lb.	.26 /	.29
9-88	lb.	.32 /	.35
Cabflex DDA	lb.	.435 /	.515
DDP, Di-OP, DOP, ODP	lb.	.305 /	.385
Di-BA, Di-OA, DOA, ODA	lb.	.435 /	.515
Di-OZ	lb.	.48 /	.5575
Cabol 100	lb.	.02 /	.11
Chlorowax 40	lb.	.155 /	.165
70	lb.	.18 /	.19
70S	lb.	.21 /	.22
LV	lb.	.175 /	.185
Darex dibutyl phthalate	lb.	.30 /	.33
DIOP	lb.	.305 /	.355
DOP	lb.	.305 /	.335
Dinopol 235	lb.	.355 /	.385
IDO	lb.	.305 /	.335
MOP	lb.	.325 /	.355
Dow Plasticizer No. 5	lb.	.315 /	.54
Resin 276-V2,-V9	lb.	.265 /	.325
Drapex 3.2	lb.	.40 /	.49
Dutch Boy Plasticizer NL-A10 (DBP)	lb.	.30 /	.33
NL-A20 (DOP), NL-A30 (DIOP)	lb.	.305 /	.335
NL-C20 (DOS)	lb.	.61 /	.63
NL-F21	lb.	.395 /	.425
NL-F31	lb.	.44 /	.47
NL-F41	lb.	.48 /	.51
NL-A54	lb.	.295 /	.325
Elastex 10-P, 28-P	lb.	.305 /	.345
40-P	lb.	.27 /	.31
50-B	lb.	.25 /	.29
60-A	lb.	.425 /	.455
80-P	lb.	.295 /	.335
90-P	lb.	.305 /	.345
DCHP	lb.	.59 /	.61
Ethox	lb.	.50 /	.525
Flexol 2GB	lb.	.35 /	.3775
3G	lb.	.53 /	.55
3GH	lb.	.44 /	.46
3G0	lb.	.53 /	.55
4G0	lb.	.325 /	.355
8N8	lb.	.355 /	.395
10-10, 810, CC-55, DOP	lb.	.305 /	.335
77-G, 426	lb.	.27 /	.31
A-26	lb.	.425 /	.455
B-400	lb.	.25 /	.29
R2H	lb.	.59 /	.595
T0F	lb.	.435 /	.475
TWS	lb.	.41 /	.4375
Flexricin P-4	lb.	.30	
P-6	lb.	.36	
P-8	lb.	.32	
Good-rite GP-261	lb.	.305 /	.460
GP-233	lb.	.435 /	.585
Harflex 10	lb.	1.25 /	1.27
40	lb.	.66 /	.68
50, 80	lb.	.61 /	.63
60	lb.	.62 /	.64
90	lb.	.88 /	.90
120, 150	lb.	.305 /	.335
140, 160	lb.	.30 /	.33
180	lb.	.295 /	.325
220	lb.	.435 /	.465
260	lb.	.42 /	.45
280	lb.	.43 /	.46
300	lb.	.63 /	.66
500	lb.	.315 /	.345
Butyl stearate	lb.	.23 /	.26
Kapsol	lb.	.3225/	.3525
KP-23	lb.	.29 /	.32
-90	lb.	.45 /	.48
-140	lb.	.46 /	.485
-201	lb.	.5825/	.5925
-220	lb.	.31 /	.34
-555	lb.	.45 /	.475
Kronisol	lb.	.33 /	.355
Kronitex AA, I, K-3, MX	lb.	.33 /	.36
Marvinol decylbutyl phthalate	lb.	.27 /	.30
Dibutyl phthalate	lb.	.30 /	.33
Sebacate	lb.	.665 /	.69
Diisooctyl adipate	lb.	.435 /	.465
Phthalate	lb.	.305 /	.335
Dinonyl adipate	lb.	.445 /	.475
Dioctyl adipate	lb.	.435 /	.465
Phthalate	lb.	.305 /	.365
Sebacate	lb.	.615 /	.64
Epoxy plasticizer	lb.	.345 /	.37
Isooctyl decyl phthalate	lb.	.305 /	.335
Tricresyl phosphate	lb.	.33 /	.36
Methox	lb.	.385 /	.41
Monsanto dibutyl phthalate	lb.	.30 /	.33
Diethyl phthalate	lb.	.25 /	.28
Dimethyl phthalate	lb.	.275 /	.305
Diphenyl phthalate	lb.	.5175/	.5375
DIDA, DOA	lb.	.425 /	.455
DIDP, DIOP, DOP	lb.	.305 /	.335
HB-20	lb.	.15 /	.17
HB-40	lb.	.22 /	.24
Orthonitrobiphenyl	lb.	.13 /	.15
Tricresyl phosphate	lb.	.33 /	.36
Triphenyl phosphate	lb.	.39 /	.40
Ohio-Apex butyl oleate	lb.	.2325/	.26
Stearate	lb.	.22 /	.25
Diallyl phthalate	lb.	.4975/	.5225
Dibutyl phthalate	lb.	.30 /	.33
Dicapryl phthalate	lb.	.295 /	.325
Di-Carbitol phthalate	lb.	.40 /	.425
Diisodecyl phthalate	lb.	.305 /	.335
Dioctyl phthalate	lb.	.305 /	.335
D.I.O.P.	lb.	.305 /	.335
Tributyl phosphate	lb.	.50 /	.53
Ohopex Q-10	lb.	.295 /	.325
R-9	lb.	.3525/	.3775
Paraplex G-60, G-61	lb.	.3251/	.35
Pfizer acetyl tributyl citrate, tech.	lb.	.32 /	.57
Acetyl triethyl citrate, tech.	lb.	.36 /	.57
Triethyl citrate	lb.	.4575/	.58
Plasticizer 1	lb.	1.17 /	1.37
Plasticizer 120	lb.	.44 /	.49
Plastoflex #3	lb.	.52 /	.57
#520	lb.	.36 /	.435
D B E	lb.	.50 /	.55
MGB	lb.	.32 /	.40
SP-2	lb.	.43 /	.48
VS	lb.	.38 /	.4575
Plastolein 9050 DHZ	lb.	.52 /	.555
9055 DGP	lb.	.28 /	.315
9057 DIOZ	lb.	.48 /	.515
9058 DOZ	lb.	.48 /	.515
9250 THFO	lb.	.3425/	.3775
9715 Polymeric	lb.	.37 /	.405
9720 Polymeric	lb.	.37 /	.405
Polycizer 162, 562, 662	lb.	.305 /	.335
332, 532, 632	lb.	.425 /	.455
PX-104	lb.	.30 /	.39
-108, -118, -138	lb.	.305 /	.395
-114	lb.	.27 /	.36
-208, -238	lb.	.435 /	.525
-209	lb.	.445 /	.535
-404	lb.	.665 /	.75
-438	lb.	.615 /	.70
-809	lb.	.345 /	.43
-917	lb.	.33 /	.42
Pycal 40	lb.	.3875/	.4375
60	lb.	.60 /	.635
62	lb.	.80 /	.835
94	lb.	.3275/	.3775
140	lb.	.35 /	.40
170	lb.	.275 /	.325
194	lb.	.2775/	.3275
Santicizer 1-H	lb.	.50 /	.51
3	lb.	.46 /	.47
8	lb.	.43 /	.44
9	lb.	.39 /	.42
140	lb.	.33 /	.36
141	lb.	.34 /	.37
160	lb.	.25 /	.28
601	lb.	.32	
602	lb.	.305	
B-16	lb.	.4875/	.4975
E-15	lb.	.5075/	.5375
M-17	lb.	.4275/	.4575
Staflex AX	lb.	.43	
BR	lb.	.26 /	.29
CP	lb.	.28 /	.31
DBES, DOS	lb.	.61 /	.635
DIOA, ODA	lb.	.435 /	.465
DIOP, DOP, MP	lb.	.305 /	.335
DOZ	lb.	.48 /	.5075
IXA	lb.	.32 /	.35
KA	lb.	.36 /	.3875
KD	lb.	.44 /	.4675
Witcizer #100	lb.	.26 /	.27
#101	lb.	.31 /	.32
#200	lb.	.195 /	.205
#201	lb.	.235 /	.245
#300	lb.	.30 /	.33
#312, 313	lb.	.305 /	.33
#412	lb.	.435 /	.465

Solvents

Enjay acetone	gal.	.07 /	.10
Isopropyl acetate	gal.	.10 /	.13
Methyl ethyl ketone	gal.	.11 /	.14
Secondary butyl acetate	gal.	.1075/	.1375
Butyl alcohol	gal.	.11 /	.14
Petrohol 91%	gal.	.35 /	.55
95%	gal.	.37 /	.57
99%	gal.	.39 /	.59

Stabilizers

Advastab #3, #52, OM-10	lb.	1.90 /	2.00
17-M	lb.	3.00 /	3.25
#21	lb.	1.00 /	1.18
#21 new, #143, E-6-B	lb.	.80 /	.90
#42	lb.	.83 /	.93
#48-79, C-77, XE-82	lb.	.85 /	.95
50-LT, P-1835, T-72	lb.	3.20 /	3.35
89-X	lb.	.75 /	.80
BA-13-P, BC-105	lb.	.75 /	.85
BC-12	lb.	.87 /	.95
CH-14, -20	lb.	.63 /	.70
E-49	lb.	.60 /	.65
E-98	lb.	.55 /	.65
JCX	lb.	.62 /	.68
L paste	lb.	.65 /	.70
OM-18	lb.	3.10 /	3.35
P-1835, T-72	lb.	3.20 /	3.35
PS-38, ZN-9	lb.	.50 /	.65
SN	lb.	.47 /	.53
V-1-N	lb.	.40 /	.48
VL-3	lb.	.95 /	1.05
X23-74	lb.	.70 /	.80
X30-6	lb.	.60 /	.70
X30-15	lb.	.65 /	.75
Barca 10	lb.	.75 /	.80
Baker barium ricinoleate	lb.	.70	
Calcium ricinoleate	lb.	.55	
Dutch Boy Barinac	lb.	.70	
Calstar	lb.	.36	
CS-137	lb.	1.25	
DS-207	lb.	.54 /	.555
Dyphos	lb.	.57 /	.585
50A	lb.	.335	
Dythal	lb.	.395 /	.41
L-26	lb.	.50	
Leadstar	lb.	.39	
Normal lead maleate	lb.	.4475	
Normasal	lb.	.46	
Pearlescent pigment	lb.	1.00	
Plumb-O-Sil-A	lb.	.2975	
-B	lb.	.3125/	.36
-C	lb.	.3425/	.375
Tribase	lb.	.265 /	.28
-E	lb.	.215	
Trimal	lb.	.435	
Harshaw 1-V-3	lb.	.43	
1-V-4	lb.	.68	
1-V-7	lb.	.66 /	.71
2-V-4	lb.	.85 /	.90
2-V-7	lb.	1.10 /	1.15
2-V-8	lb.	1.30	
2-V-400	lb.	.80 /	.85
5-V-1	lb.	.41	
5-V-22	lb.	.49	
7-V-1	lb.	.90 /	.95
7-V-2	lb.	.95 /	1.00
7-V-4	lb.	1.18 /	1.23
8-V-1	lb.	1.10 /	1.15
8-V-5	lb.	.80 /	.85
8-V-100	lb.	.84 /	.89
9-V-1	lb.	.76 /	.81
12-V-5	lb.	.75	
22-V-1	lb.	1.28	
24-V-1	lb.	1.28 /	1.33
28-V-2	lb.	1.18	
128-V-5	lb.	.86	
281-V-4	lb.	.90	
Metasap 613-A	lb.	.69	
613-B	lb.	.84	
613-C	lb.	1.06	
621	lb.	.88	
624	lb.	.75	
Cadmium stearate	lb.	1.40 /	1.44
Fused stearates, calcium 602-A	lb.	.25 /	.30
Dibasic lead stearate	lb.	.56	
Lead 611	lb.	.32 /	.37
Lead stearate	lb.	.39 /	.44
Nuostable V-1	lb.	.54 /	.59
V-2	lb.	.39 /	.44
V-10	lb.	.70 /	.75
V-20	lb.	1.30 /	1.35
V-21	lb.	1.29 /	1.34
V-30	lb.	.90 /	.95
V-31	lb.	.80 /	.85
V-40	lb.	1.18 /	1.23
V-42	lb.	.65 /	.70
V-43	lb.	.75 /	.80
V-44	lb.	.90 /	.95
V-45	lb.	1.10 /	1.15
V-50	lb.	.49 /	.54
V-60	lb.	.37 /	.42
V-70	lb.	.68 /	.73
V-80	lb.	2.80 /	2.85
V-81	lb.	2.90 /	2.95
Stabelan E	lb.	1.35 /	1.50
HR, liquid	lb.	.65 /	.75
Paste	lb.	.85 /	.95
Powder	lb.	.95 /	1.05
HR-50	lb.	.75 /	.90
XL	lb.	.55 /	.65
Stabilizer #3, 52	lb.	1.90 /	2.00
17-M	lb.	3.00 /	3.25
#42	lb.	.83 /	.93
89-X	lb.	.75 /	.80
#143	lb.	.80 /	.90
A-5	lb.	1.25	
BC-12	lb.	.87 /	.95
BC-105	lb.	.75 /	.85
C-2	lb.	1.65	
C-77	lb.	.85 /	.95
CH-14	lb.	.63 /	.70
CH-20	lb.	.63 /	.65
D-22	lb.	1.99 /	2.05
E-6-B	lb.	.80 /	.90
E-49	lb.	.60 /	.65
E-98	lb.	.55 /	.65
JCX	lb.	.62 /	.68
L-Paste	lb.	.60 /	.65
Mark E	lb.	.72 /	.85
M	lb.	.73 /	.83
PL	lb.	.74 /	.84
TT	lb.	.77 /	.91
V	lb.	.91 /	1.04
X	lb.	2.50 /	2.75
XI	lb.	.87 /	1.01
XV	lb.	.92 /	1.01
XX	lb.	.63 /	.74
OM-10	lb.	1.90 /	2.00
-18	lb.	3.10 /	3.35
P-1835	lb.	3.20 /	3.35
PS-38	lb.	.50 /	.65
SN	lb.	.47 /	.53
T-72	lb.	3.20 /	3.35
V-I-N	lb.	.40 /	.48
VL-3	lb.	.95 /	1.05
Staflex QMXA	lb.	.70	
50% in DOP	lb.	.52	
OY	lb.	1.00 /	1.20
Stayrite #10	lb.	.33 /	.37
#15	lb.	.54 /	.57
#20	lb.	.38 /	.42
#22	lb.	1.32 /	1.34
#25	lb.	.36 /	.40
#70, 75, 80, 90	lb.	.69 /	.70
#229	lb.	.47 /	.50
P-10	lb.	.40 /	.44
Thermolite No. 12	lb.	2.00 /	2.26
13	lb.	3.10 /	3.78
15	lb.	4.13	
17, 99	lb.	3.00	
20	lb.	3.25	
31	lb.	3.05 /	3.25
Vanstay HT	lb.	.90 /	.92
L	lb.	.33 /	.35
R	lb.	.88 /	.90
S	lb.	.63 /	.65

Wetting Agents

Advawet X-212	lb.	.50 /	.55
Poly-lube No. 4	qt.	1.45 /	1.94